METRIC FOR THE SELF-ASSESSMENT OF AVIATION SAFETY MANAGEMENT SYSTEMS

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CREATING TOMORROW

BACKGROUND

CURRENT CHALLENGES FOR AVIATION COMPANIES

- Small – Medium Enterprises: lack of adequate safety/operational data to monitor safety

- Large companies: operational/safety data available, but they need leading metrics of better quality

- How to move from compliance-based to performance-based monitoring?

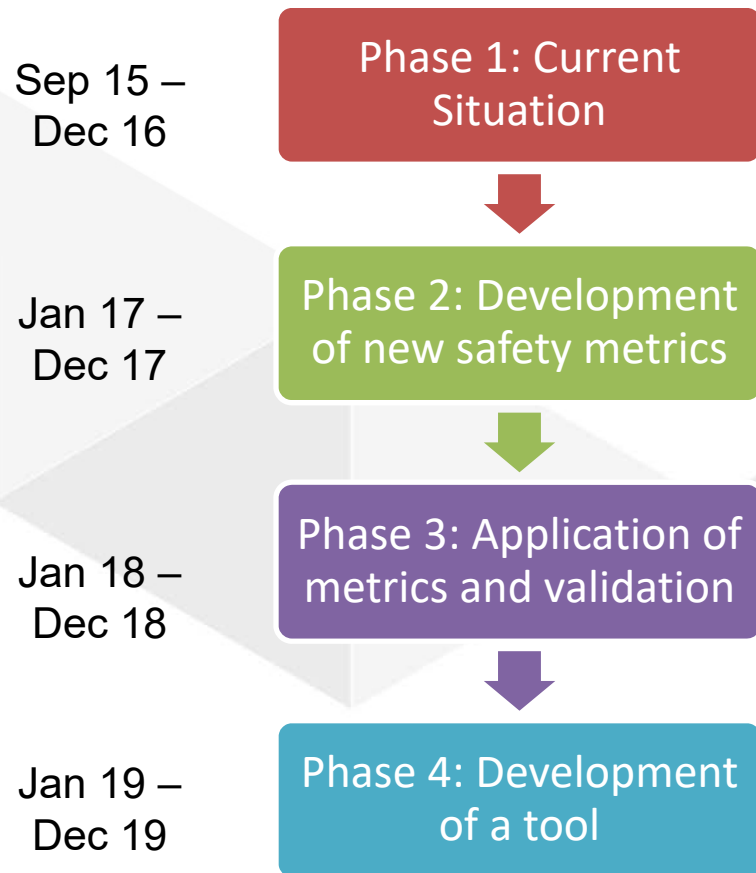Safety Management International Collaboration Group 2012
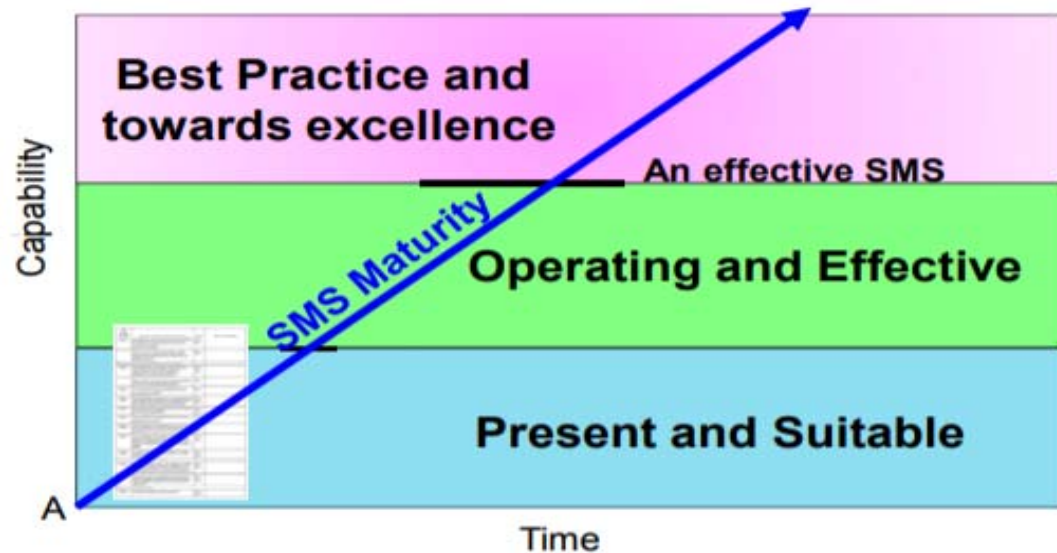
WE INITIATED A PROJECT TO HELP SME'S TO BETTER MEASURE THEIR SAFETY

- How to measure the safety of operations without the benefit of large amounts of safety relevant data?

- Investigate link between specific safety management activities in aviation and safety outcomes

- The project will create new knowledge in leading safety indicators

- Thus enable both SMEs and large companies to measure proactively the safety of their operational activities.
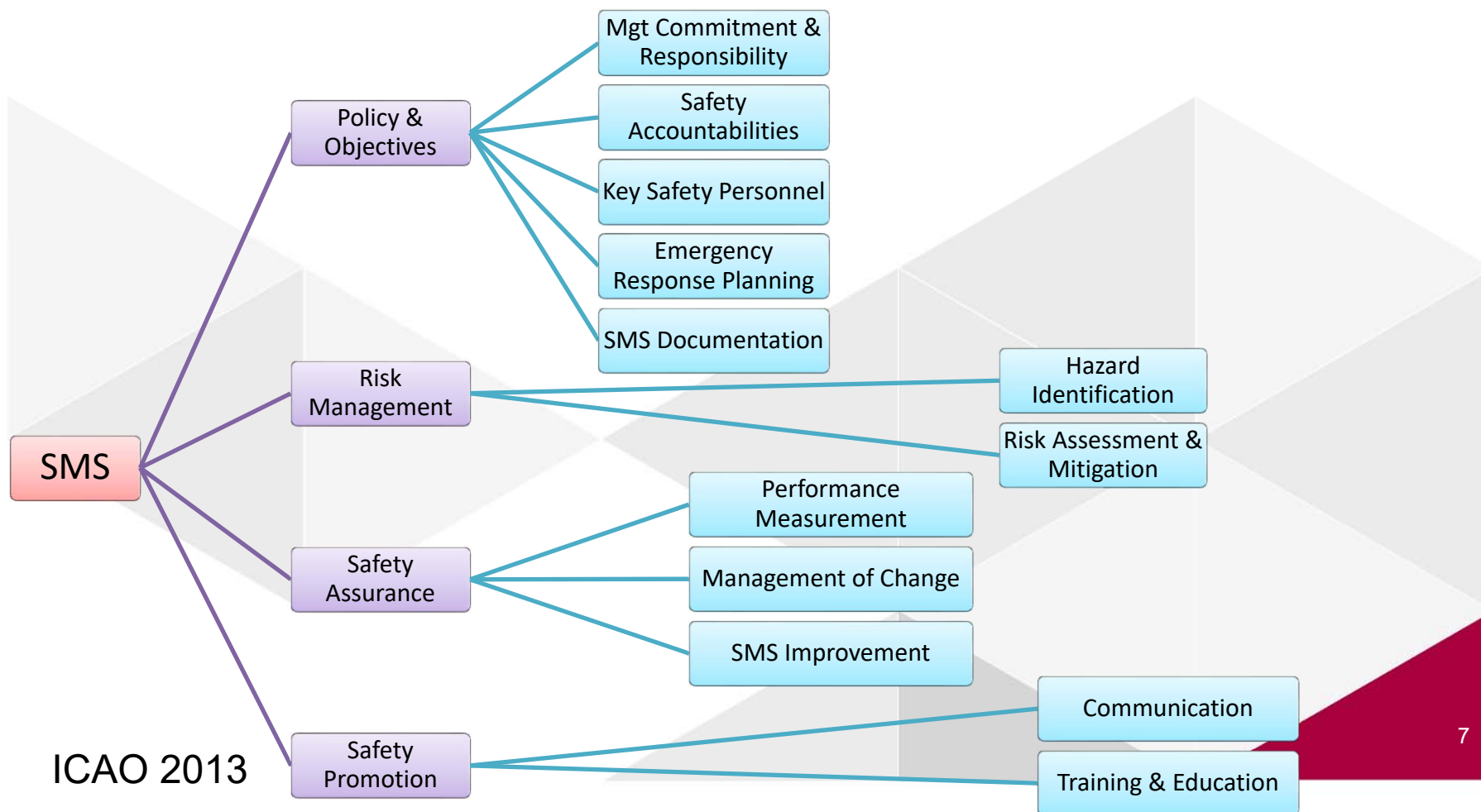
RESEARCH PROJECT

Sep 15 –
Dec 16

Phase 1: Current Situation

Jan 17 –
Dec 17

Phase 2: Development of new safety metrics

Jan 18 –
Dec 18

Phase 3: Application of metrics and validation

Jan 19 –
Dec 19

Phase 4: Development of a tool

SMS ASSESSMENT IS ONE OF 6 POTENTIAL NEW SAFETY METRICS

- **SMS assessment**
- Safety culture prerequisites
- Risk control effectiveness
- Resource gaps
- Work-as-imagined vs work-as-done at the task level
- System complexity / coupling

THE ICAO SMS CONSISTS OF 4 COMPONENTS AND 12 ELEMENTS

Hogeschool van Amsterdam
Amsterdam University of Applied Sciences

SMS

- **Policy & Objectives**
  - Mgt Commitment & Responsibility
  - Safety Accountabilities
  - Key Safety Personnel
  - Emergency Response Planning
  - SMS Documentation

- **Risk Management**
  - Hazard Identification
  - Risk Assessment & Mitigation

- **Safety Assurance**
  - Performance Measurement
  - Management of Change
  - SMS Improvement

- **Safety Promotion**
  - Communication
  - Training & Education

ICAO 2013

GENERAL REMARKS ON CURRENT SMS ASSESSMENT TOOLS IN AVIATION

- Current tools have been developed mainly through brainstorming and experience – not using a systematic analysis
- Difficult to customize to size and complexity of company
- Vague measurement scales - unquantified assessment results
- Design and Implementation do not consider:
  - timeliness of SMS processes
  - mutual dependencies of SMS activities
- Effectiveness of SMS not measured – often confused with *institutionalisation* or *outcomes*

Institutional-isation → Capability → Effectiveness → Outcomes

WORK AS IMAGINED VS WORK AS DONE

Work as Imagined	Work as Done
Dislocated in time/place from execution	Real-time execution
No/limited feedback	Immediate feedback
Very stable	Dynamic
Predetermined input variability	Real-time input variability
Stable environment	Real-time environment variability
Relies on sufficient training & knowledge	Voids in training & knowledge
Motivation taken for granted	Sensitive to motivation

- Hollnagel (2009): Efficiency-Thoroughness-Trade-Off
- Leveson (2011): Flaws in Feedback and Control Inputs
- Dekker (2014): Work as Done vs Work as Imagined
- Hale & Borys (2013): Work to Rule
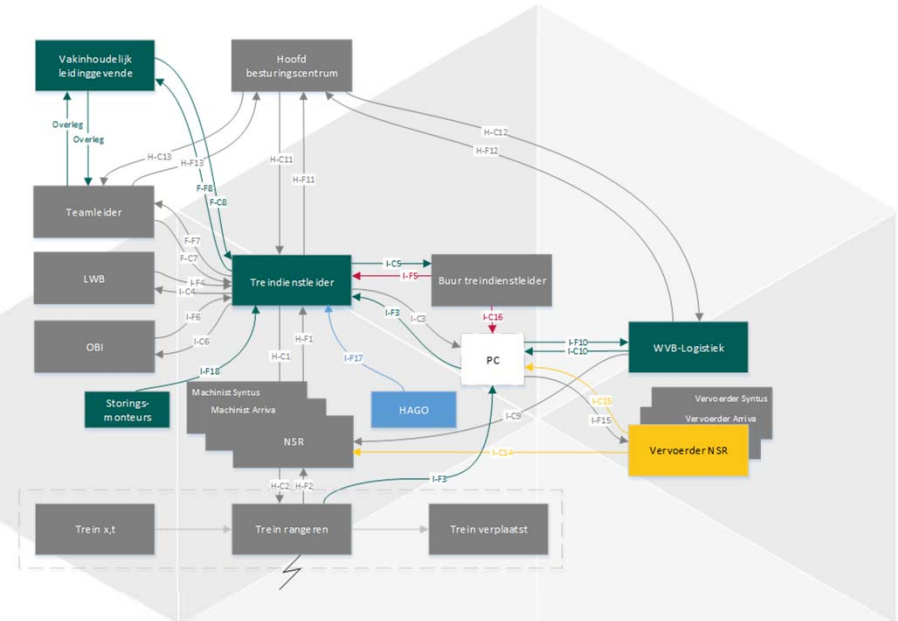- Shorrock (2016): The Varieties of Human Work

STAMP HAS BEEN USED TO IDENTIFY THE GAP BETWEEN WAD AND WAI

Example

Work-as-Imagined
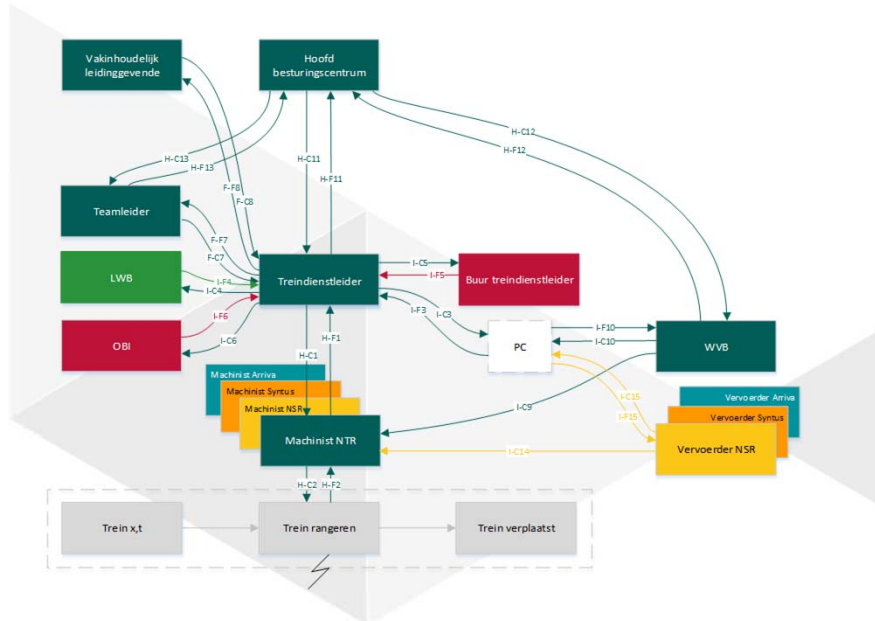
Work-as-Done location X

Boelhouwer 2016

WHY USE STPA?

- UCAs -> Requirements: reflect the institutionalisation of SMS.
- Loss scenario's:
  - reasons that have led to the UCAs detected.
  - Ineffective/incorrect CAs: reflect capability factors to run the SMS activities.
  - SMS can be correctly designed and implemented according to its design, but its deliverables can yet be unachievable.
  - A low capability level can signal that an SMS might not be suitably tailored to the organisation.
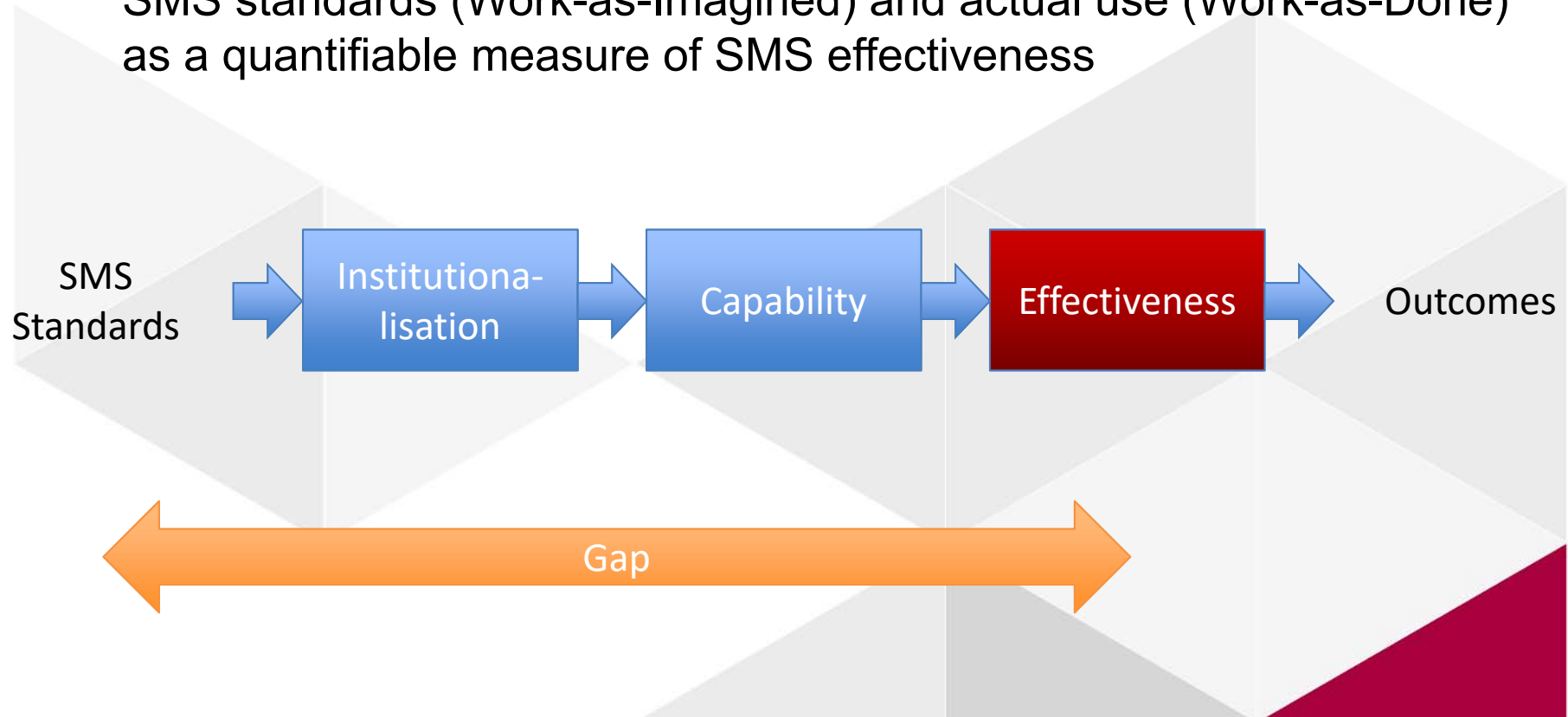
![Hogeschool van Amsterdam - Amsterdam University of Applied Sciences](logo)

OBJECTIVE

OBJECTIVE

- Generate a self-assessment tool to determine the gap between the SMS standards (Work-as-Imagined) and actual use (Work-as-Done) as a quantifiable measure of SMS effectiveness
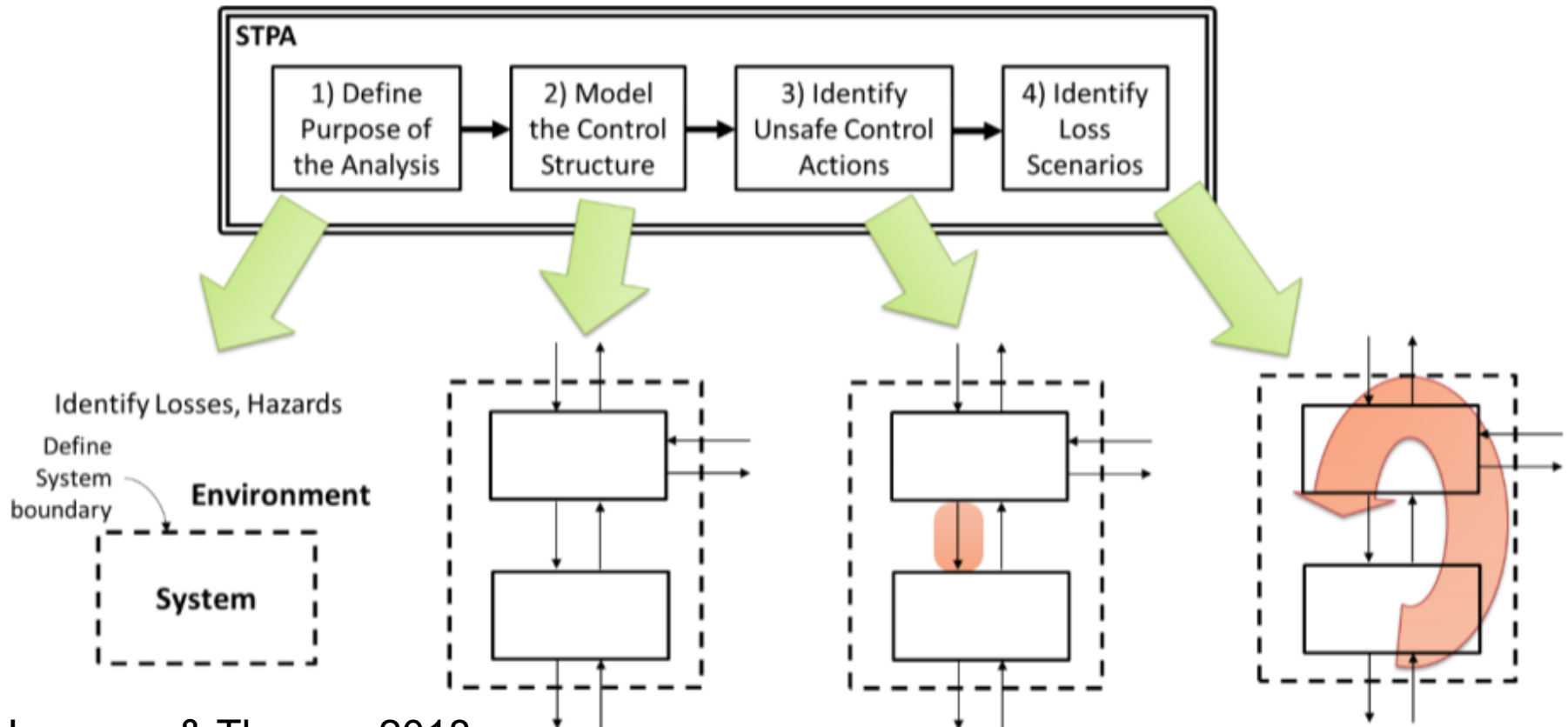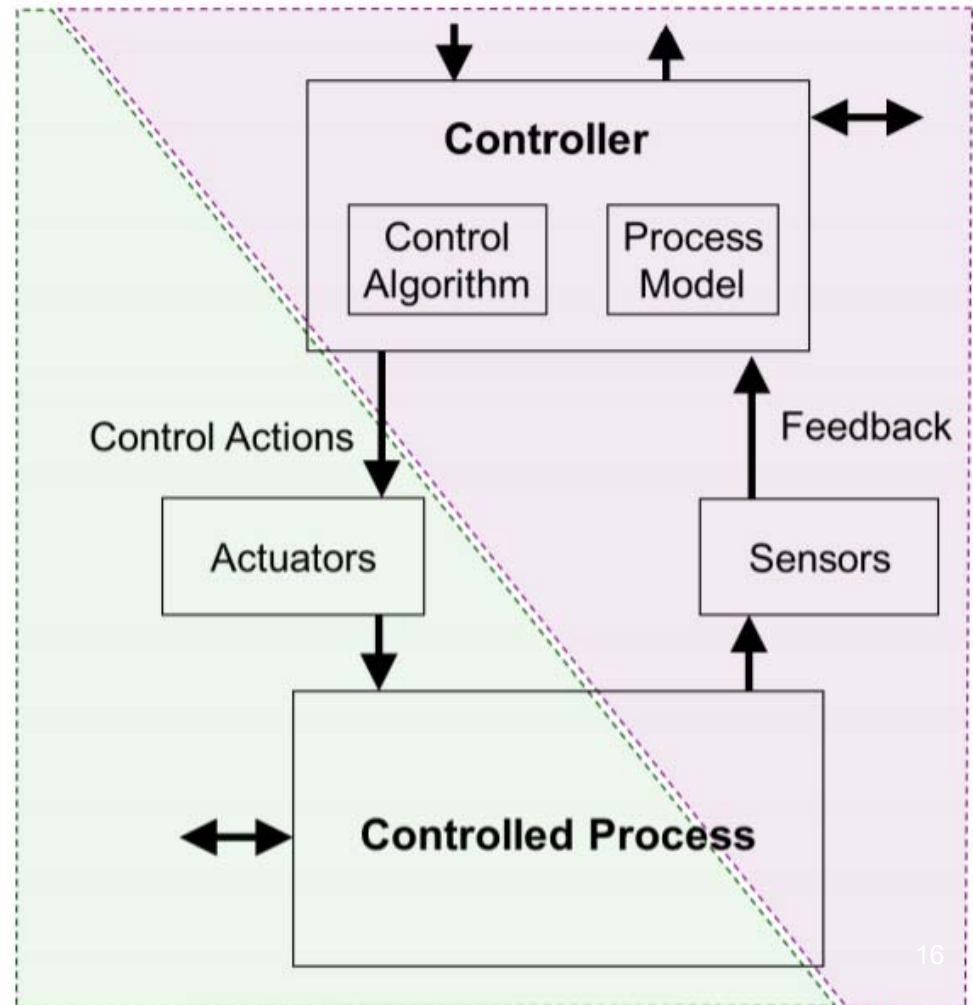
SMS Standards → Institutionalisation → Capability → Effectiveness → Outcomes

Gap

METHOD

WE USED STANDARD STPA

Leveson & Thomas 2018

LOSS SCENARIO'S

Leveson & Thomas 2018

DISTANCE VECTORS ALLOW FOR COMPARISON OF WAD AND WAI

WaI   WaD
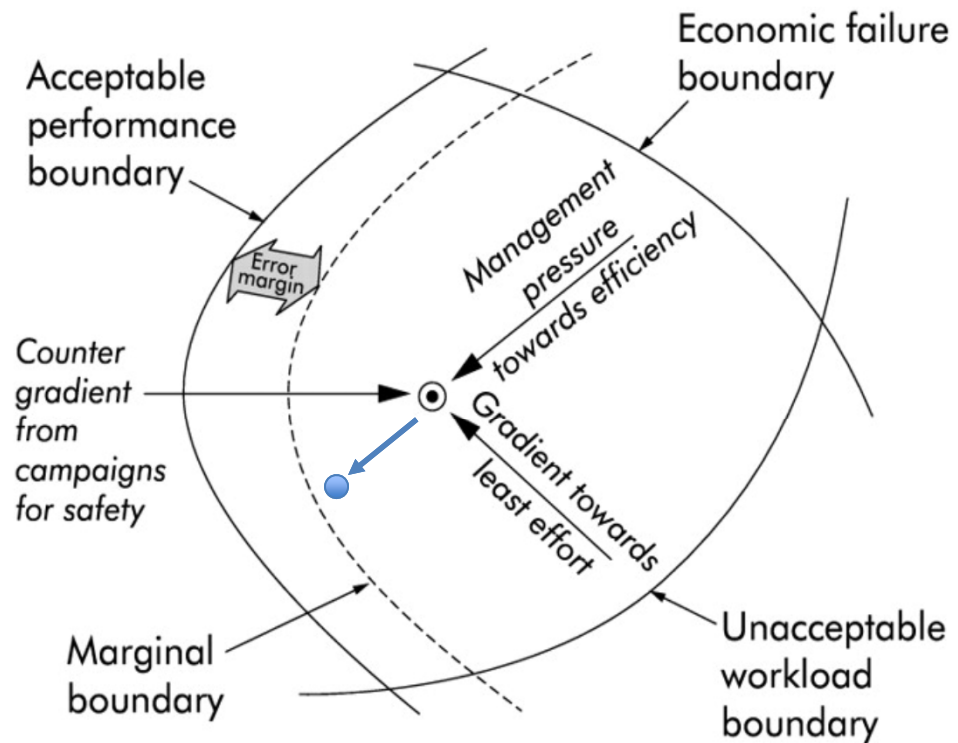

Modified from Rasmussen

RESULTS

SYSTEM ACCIDENTS

- A-1. Level 1 SMS audit findings for non/compliance[1]
- A-2. Poor safety performance

[1] Assumption: ICAO standard reflects sufficient & necessary SMS design

SYSTEM HAZARDS

- H-1. SMS is not designed according to standards (A-1, A-2)
- H-2. SMS is not implemented according to standards (A-1, A-2)
- H-3. SMS is not suitable for the organization (A-1, A-2)
- H-4. SMS is not effective (A-2)

SMS Standards → Institutiona-lisation → Capability → Effectiveness → Outcomes
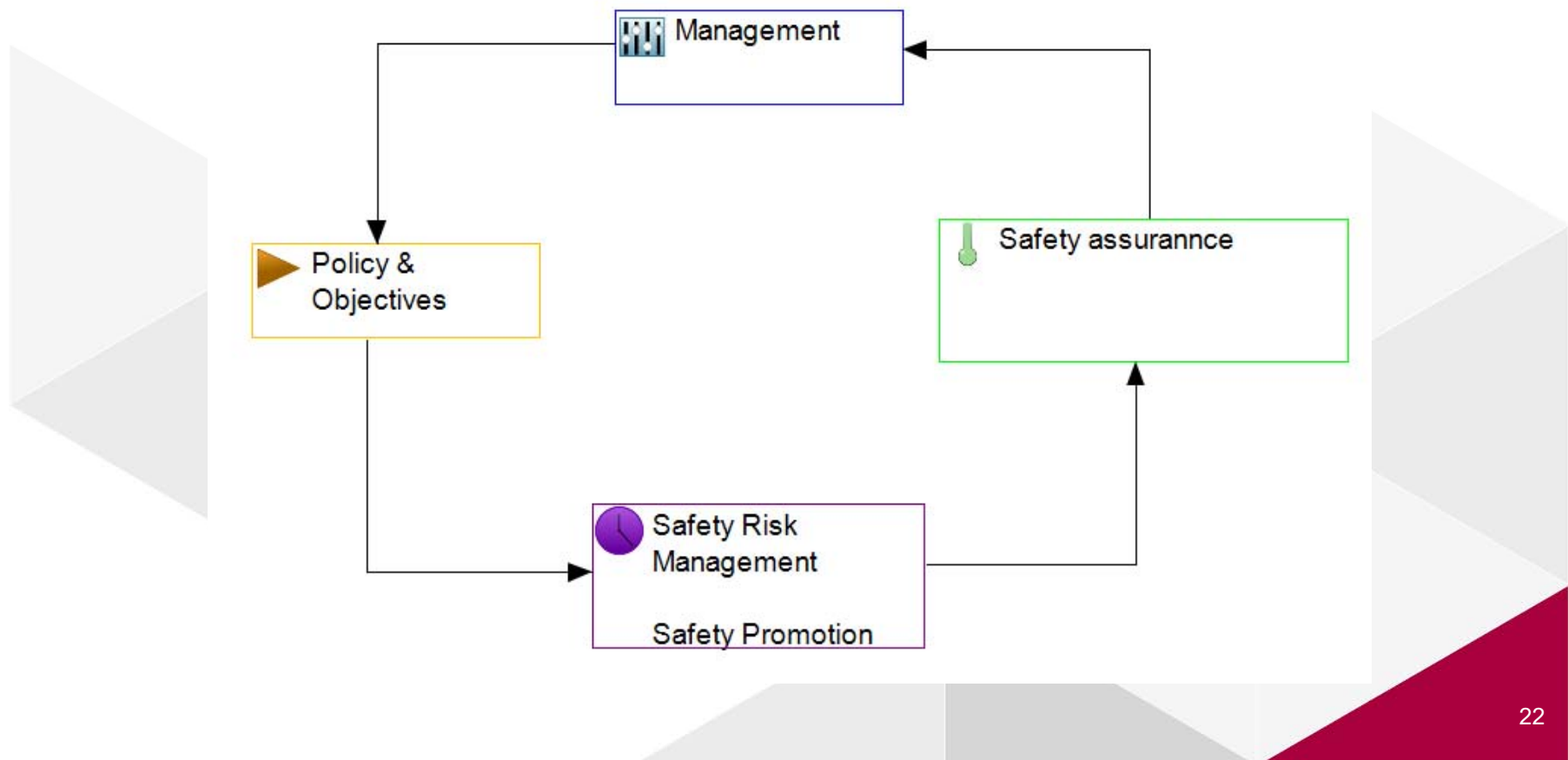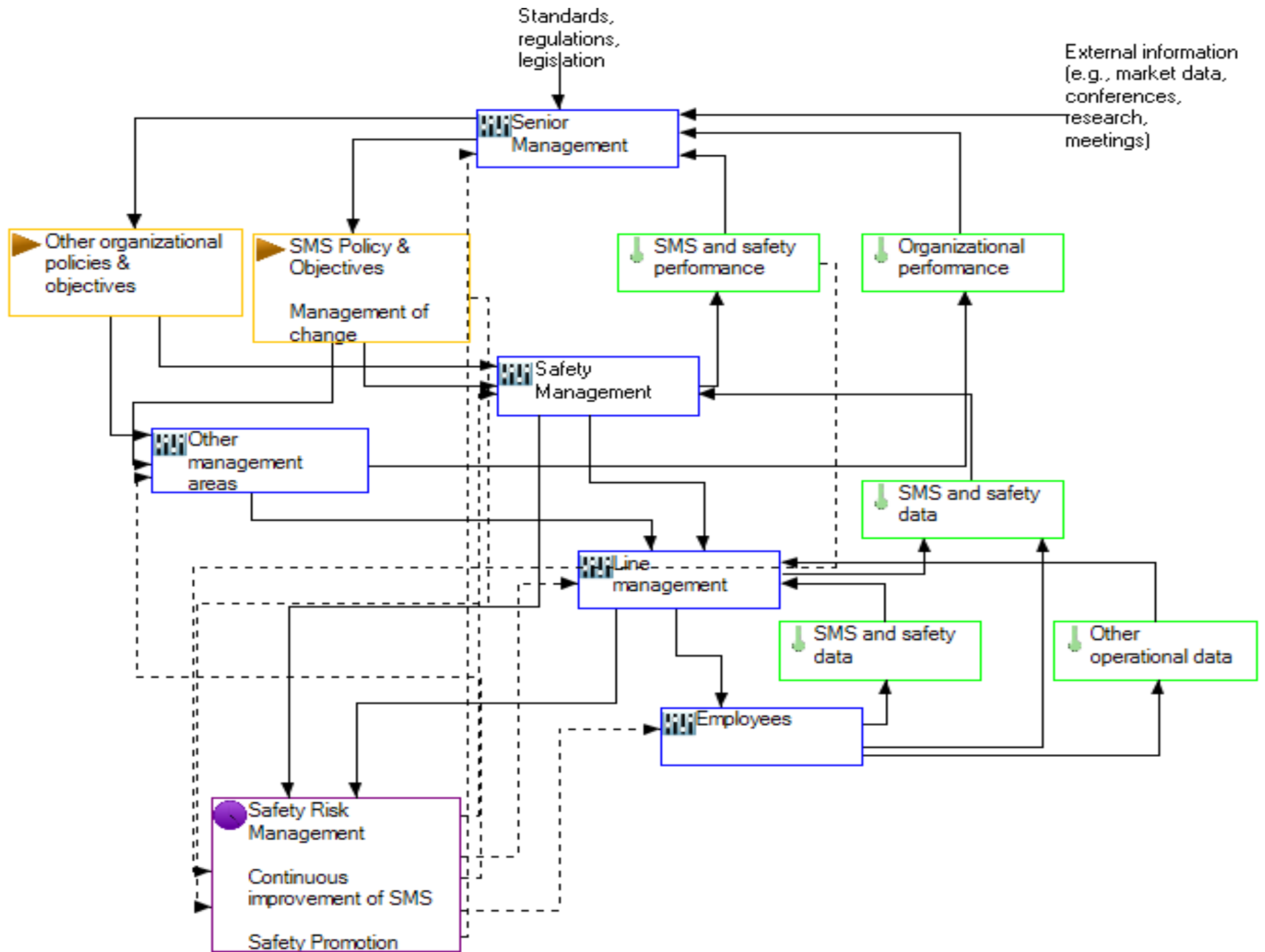
20
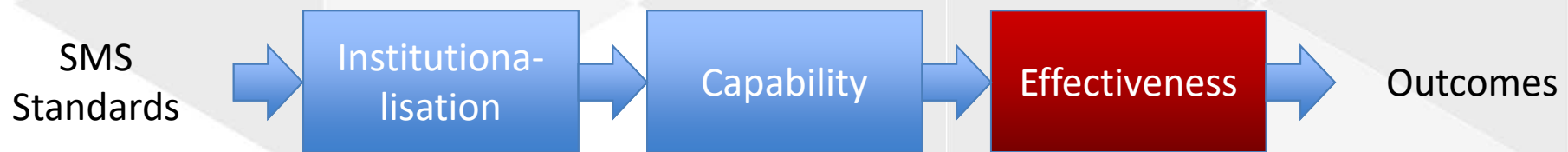
AVAC-SMS: SYSTEM LEVEL CONSTRAINTS

- SR-1: SMS shall be designed according to standards
- SR-2: SMS shall be implemented according to standards
- SR-3: SMS shall be suitably scaled for the organization
- SR-4: SMS shall be effective

CONTROL HIERARCHY – HIGH-LEVEL

Standards, regulations, legislation

External information (e.g., market data, conferences, research, meetings)

Senior Management

Other organizational policies & objectives

SMS Policy & Objectives

Management of change

SMS and safety performance

Organizational performance

Safety Management

Other management areas

SMS and safety data

Line management

SMS and safety data

Other operational data

Employees

Safety Risk Management

Continuous improvement of SMS

Safety Promotion

CNTRL HIERARCHY – POLICY & OBJECTIVES
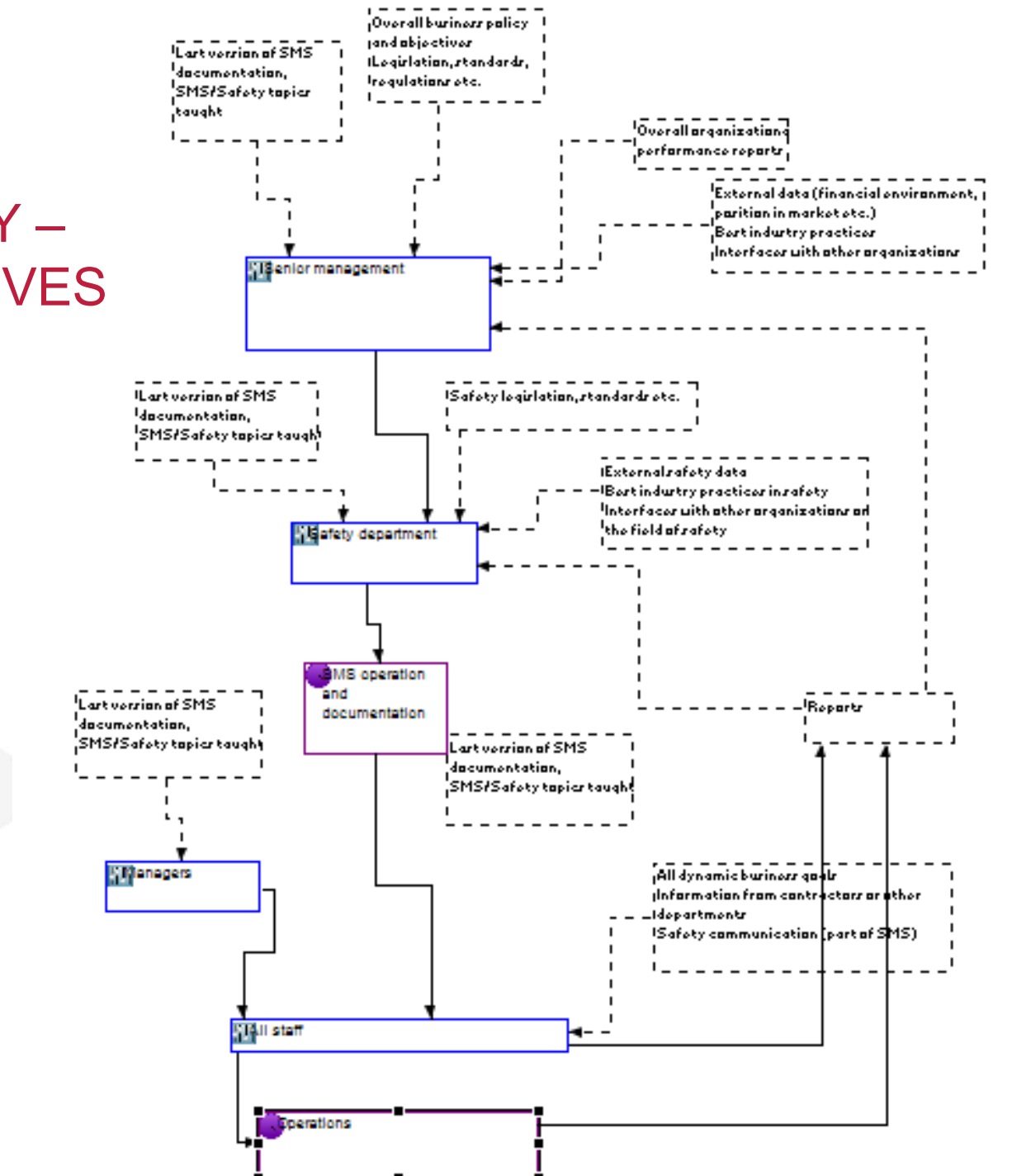
CONTROL HIERARCHY – PROMOTION

Last version of SMS documentation
SMS/safety topics taught
Safety topics communicated

Other business functions/departments

Other dynamic goals

Safety department

Management

Reports

Quality department
(Approval of working
procedures)

Tactical safety risk assessment

Temporary risk controls

Working procedures
(including risk
controls)

Operational safety risk
assesment

Staff

CONTROL HIERARCHY – ASSURANCE
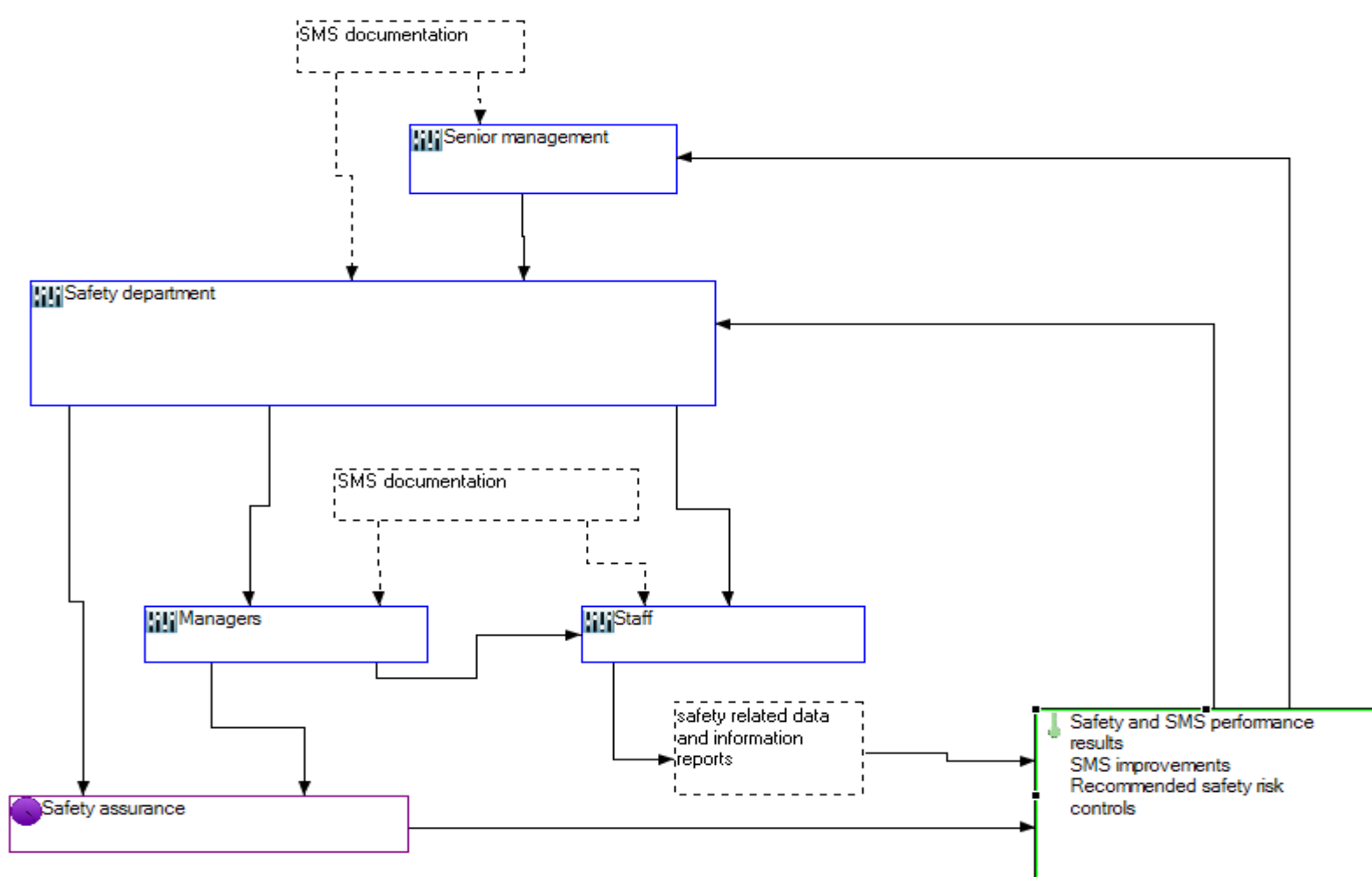
SMS component	SMS element	Control Actions (#)			Total	
		Design	Impl.	Dep.	Per line	Per Comp.
Safety Policy & Objectives	Management Commitment and Responsibility	13	8	9	30	73
	Accountabilities and Responsibilities	2	2	4	8	
	Assignment of Resources & Appointment of Key Personnel	5	5	1	11	
	Coordination of Emergency Response Planning	6	3	4	13	
	SMS Documentation	4	4	3	11	
Safety Risk Management	Hazard Identification	4	4	3	11	23
	Risk Assessment and Mitigation	2	5	5	12	
Safety Assurance	Safety Performance Monitoring & Measurement	7	6	7	20	36
	The Management of Change	2	3	5	10	
	Continuous Improvement of SMS	1	2	3	6	
Safety Promotion	Training & Education	2	3	3	8	17
	Safety Communication	3	5	1	9	
Total		51	50	48	149	149

EXAMPLES OF HAZARDOUS IF PROVIDED:

1. Defines a just culture policy   When have not achieved maximum internal agreement
2. Defines safety objectives   when safety policy has not been defined
3. Defines policy/procedures for voluntary reporting   when just culture policy has not been defined
4. Defines safety accountabilities   when overall organisational acountabilities have not been defined
5. Defines safety responsibilities   when authorities per role/function have not been defined
6. Appoints safety personnel   When competency criteria have not been defined
7. Provides technical equipment for the implementation of safety policy   When specifications have not been defined
8. Approves organisational changes   when a change management method has not been defined or applicability criteria are not met
9. Approves SMS changes   when possible conflicts with other management systems have not been assessed
10. Implements just culture policy   When there are no valid evidence and personal accounts
11. Performs risk assessment   when risk assessment method has not been defined
12. Develops risk controls when methodology for developing risk controls has not been defined
13. Monitors safety performance when indicators do not meet quality criteria or data are not sufficiently reliable/accurate when data analysis of voluntary or mandatory reporting systems has not been completed

EXAMPLES OF HAZARDOUS IF PROVIDED:

14. Evaluate effectiveness of all risk controls   when a method has not been defined
15. Implements organisational changes   when not approved by management or resources are not available
16. Provides safety communication   when internal or external safety information has not been collected and respective background is not known
17. Publishes an Emergency Response Plan (ERP)   when all relevant internal and external interfaces are not known
18. Defines a risk assessment method when authorities per function/role have not been defined (or not known)
19. Performs risk assessment   when risk assessment method has not been defined
20. Develops risk controls when methodology for developing risk controls has not been defined
21. Evaluate effectiveness of all risk controls   when a method has not been defined
22. Monitors safety performance when indicators do not meet quality criteria and data are not sufficiently reliable/accurate
23.   when data analysis of voluntary or mandatory reporting systems has not been completed
24. Designs safety education/training programs   when particular needs per job function/role have not been collected
25. Provides safety communication   when internal or external safety information has not been collected and respective background is not known

LOSS SCENARIO'S FOR LOW SMS INSTITUTIONALISATION

- The SMS element is documented inadequately/poorly (e.g., clarity, accuracy).

- The SMS element activities are not sufficiently known.

- Inadequate information and feedback required to perform the activities of the SMS element.

- Information and feedback required to perform the activities of the SMS element are provided with a delay.

- Information and feedback needed to perform the activities of the SMS element are corrupted or of poor quality.

LOSS SCENARIO'S FOR LOW SMS CAPABILITY

- Example questions
  - How capable do you feel of executing your tasks related to this element?
  - How adequate are the means available to you to execute the tasks related to this element?
  - To what degree do you conflict with other persons that work on the same tasks of the SMS element?
  - How adequate is the information from other organisational and SMS activities you need to execute the tasks of this element?
  - How timely do you receive necessary information from other organisational and SMS activities to execute your tasks of this element?
  - To what degree do external factors disturb you in the execution of your tasks of this element?

LOSS SCENARIO'S FOR LOW SMS EFFECTIVENESS

- Questions:
  - To what degree is the amount of activities related to this element adequate to support your daily tasks?
  - To what degree is the quality of the activities related to this element sufficient to support your daily tasks?
  - How timely are the activities related to this element executed to support your daily tasks?

SURVEY QUESTIONS REQUIRE A SCORE TO IDENTIFY GAP WAD - WAI

Controls (designed & documented, implemented, dependencies)

ASSESSMENT OF THE EXTENT TO WHICH SMS FUNCTIONS ACCORDING TO STANDARDS

SMS component	SMS element	Code	Check if:	Extent of Realising the Requirement
		MCR1	There is a safety policy	100%
		MCR2	The organisational policy views safety as core business function	70%
		MCR3	Safety personnel participate in all management meetings across different organizational levels	100%
		MCR4	Safety is a parameter during decision-making during all management meetings across different organizational levels	70%
		MCR5	Possible need to change the safety policy has been always discussed during significant changes within the organization (e.g., overall business objectives) or of external conditions	20%
		MCR6	Current safety policy is included in all safety education/training programs	0%

CONCLUSION

WE HAVE PRODUCED THE TOOL AND IT IS CURRENTLY BEING PILOTED

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- **SAFETY DEPARTMENT**
  - 149 SMS assessment points
  - 48 SMS assessment points (4 questions per SMS element):
  - 16 SMS assessment points (4 questions per SMS component):
- **MANAGERS/SAFETY STAFF AND END-USERS**
  - SMS element level: 72 questions for managers/safety staff – 36 questions for end-users
  - SMS component level: 24 questions for managers/safety staff – 12 questions for end-users
  - Overall SMS: 6 questions for managers/safety staff – 3 questions for end-users

...or contact us to participate

WE HAVE PRODUCED THE TOOL AND IT IS CURRENTLY BEING PILOTED

- **SAFETY DEPARTMENT**
  - 149 SMS assessment points: https://hva.eu.qualtrics.com/jfe/form/SV_2gZWLD0iEzsojvT
  - 48 SMS assessment points (4 questions per SMS element): https://hva.eu.qualtrics.com/jfe/form/SV_6iqnu4hqtapx5gF
  - 16 SMS assessment points (4 questions per SMS component): https://hva.eu.qualtrics.com/jfe/form/SV_9oSuREghr6Ic6I5
- **MANAGERS/SAFETY STAFF AND END-USERS**
  - SMS element level: 72 questions for managers/safety staff – 36 questions for end-users https://hva.eu.qualtrics.com/jfe/form/SV_3WavOt4xxQuUf09
  - SMS component level: 24 questions for managers/safety staff – 12 questions for end-users https://hva.eu.qualtrics.com/jfe/form/SV_4OCXRHNaFYH1DDL
  - Overall SMS: 6 questions for managers/safety staff – 3 questions for end-users https://hva.eu.qualtrics.com/jfe/form/SV_eaEi1isBzYraUHX
- Trial code for any company: 99747
- There is a question within the survey that asks the participants about their role, and then shows only the relevant questions

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LESSONS LEARNED

- STPA applicable to the management part of a socio-technical system
- Use of **loss scenario's** for STPA to determine causal factors - novel compared to other SMS tools
- Ability to zoom-in and zoom-out of the SMS - not offered by other tools
  - SMS elements (12)
  - SMS components (40)
  - Individual SMS processes (N)
- Scoring system somewhat arbitrary

THANK YOU FOR YOUR ATTENTION

SEE YOU AT EUROSTAMP:
OCT 31ST - NOV 2ND 2018, AMSTERDAM

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