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2014 STAMP Conference

MIT Partnership for a Systems Approach to Safety

"Using STAMP Principles in Risk Management of Large Scale Pipeline Projects"

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27/03/2014

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Background (1/3)

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ILF Group

Oil & Gas

- Upstream facilities
- Pipeline systems
- Underground storage facilities
- Tank farms & terminals
- Refineries & petrochemical plants

Water & Environment

- Hydropower plants
- Water transmission systems
- Water & wastewater networks
- Water & wastewater treatment plants

Energy & Climate Protection

- Thermal power plants
- Desalination plants
- Renewable energy
- Climate protection
- Power transmission & distribution systems

Transport & Structures

- Airports
- Roads
- Railways
- Urban transport systems
- Tunnels & caverns
- Buildings & structures
- Alpine resorts

Background (2/3)

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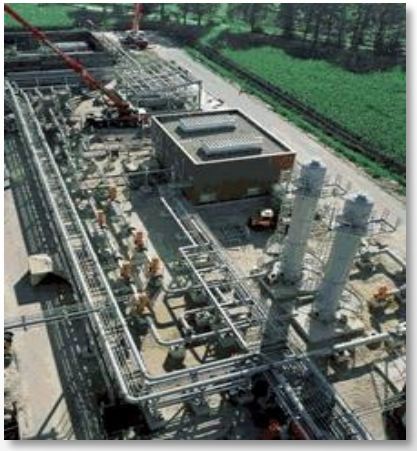
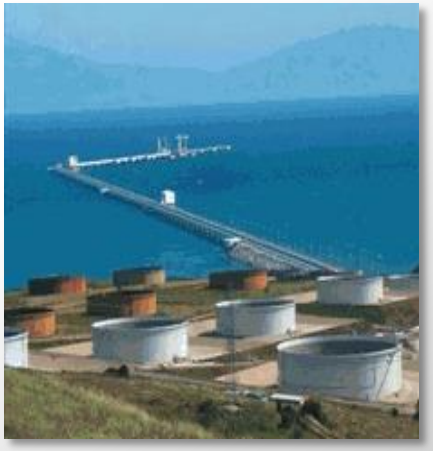
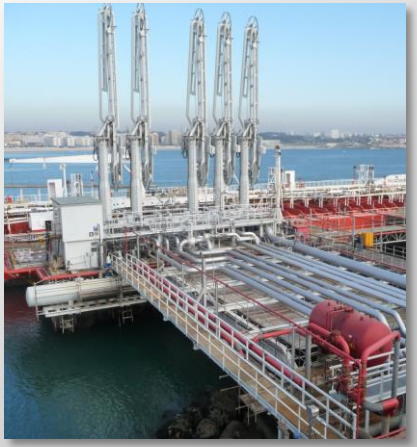
Oil & Gas

Background (3/3)

- **Motivation**
- **Previous Master Thesis > Evaluating Project Safety (System Engineering and Safety Management) in an Organization for implementation of STAMP principles**
- **Parallelism Hazard Analysis ↔ Project Risk Analysis**
  - **Resource intensive, benefits questioned**
  - **Impact on actual Project execution?**
- **Transferring techniques might aid in improving established Project Risk Management practice**
  - **e.g. PMI (Project Management Institute)**

Context of Large Scale Pipeline Projects (1/6)

- **Long Distance (Trans-National) Pipeline Systems (1/2)**
- **Several 1,000 km length; Throughputs up to 60 bcma (gas) or 100 MTA (oil)**
- **Pipe Diameters 32”, 48”, 56”; Pressures typically in class ANSI 600 (up to 100 bar)**
- **Typical large Pump Stations up to 50 MW / Compressor Stations up to 200 MW / Metering Stations / Pressure Reduction and Offtake Stations**
- **Interconnecting to other systems/ facilities**
  - **Upstream/ Downstream Pipeline Systems**
  - **Loading Terminals/ Ports**
  - **Production facilities**
  - **Storage and Refining facilities**

Context of Large Scale Pipeline Projects (2/6)

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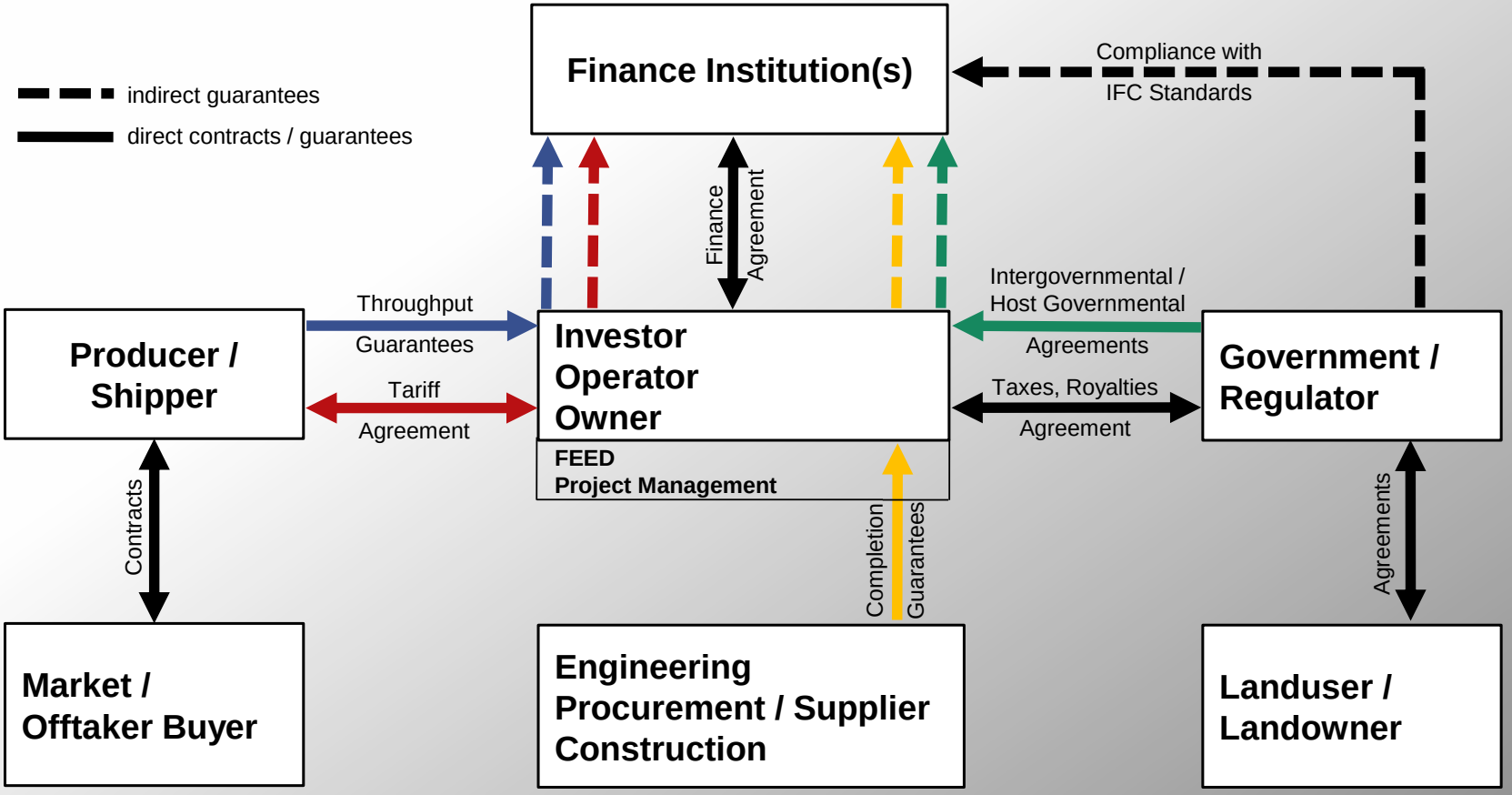
Long Distance (Trans-National) Pipeline Systems (2/2)

Context of Large Scale Pipeline Projects (3/6)

- **General Context**
- **Geopolitical aspects**
- **Developed by Joint Ventures**
  - **Pre-mature Project specific organizations**
  - **Different business & safety cultures**
- **Driven by aggressive Schedules due to commitments with**
  - **Interconnecting facilities/ projects along the value chain (supply/ demand)**
  - **Shareholders and Lenders (ROI greatly dependent on timely pipeline operation)**

Context of Large Scale Pipeline Projects (4/6)

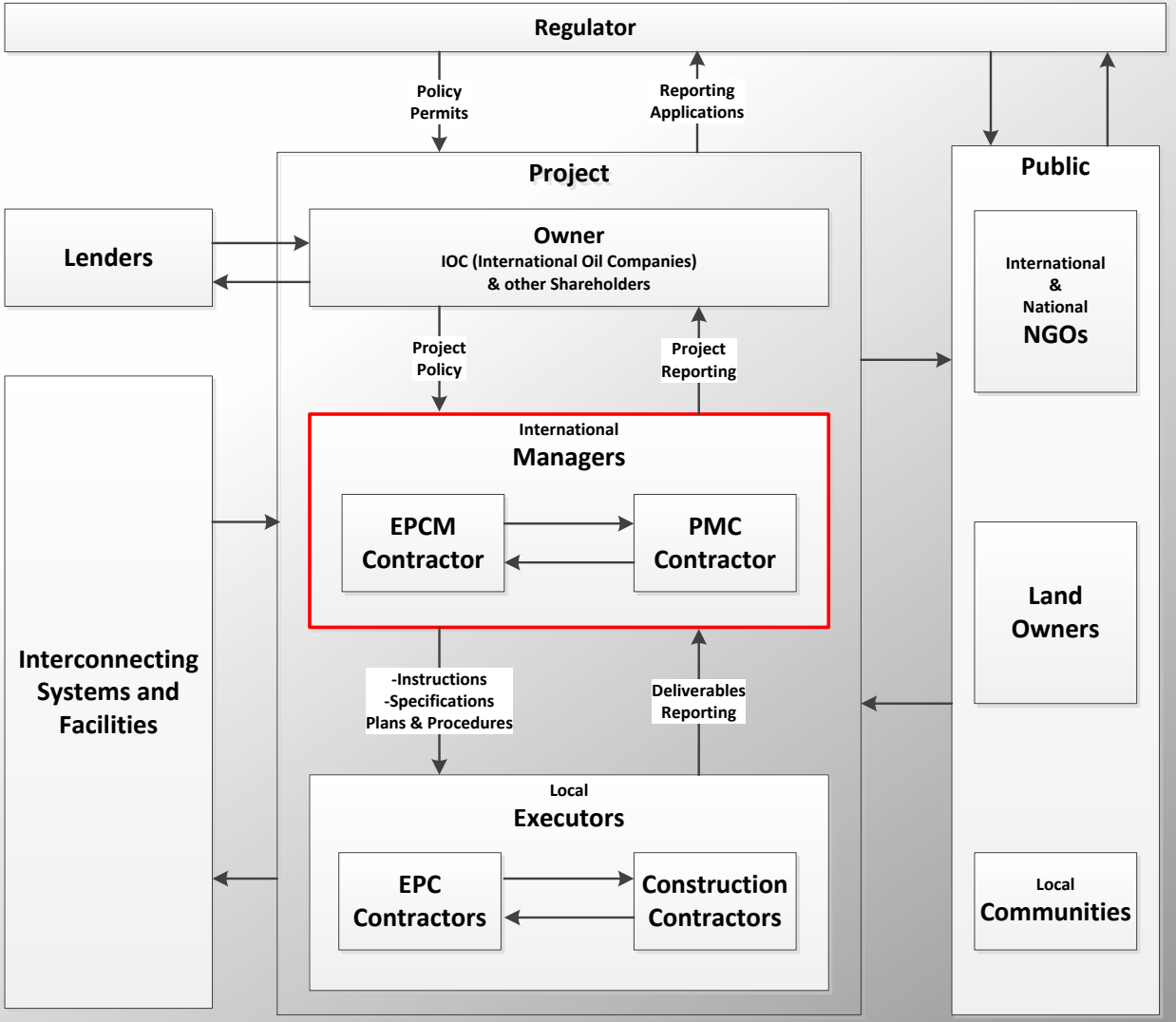
Stakeholders and Agreements Landscape



Context of Large Scale Pipeline Projects (5/6)

- **Complex Project Execution Structures**
- **Multiple contractors involved**
- **Cascading requirements difficult**

Context of Large Scale Pipeline Projects (6/6)



Risk Management in Large Scale Pipeline Projects (1/5)

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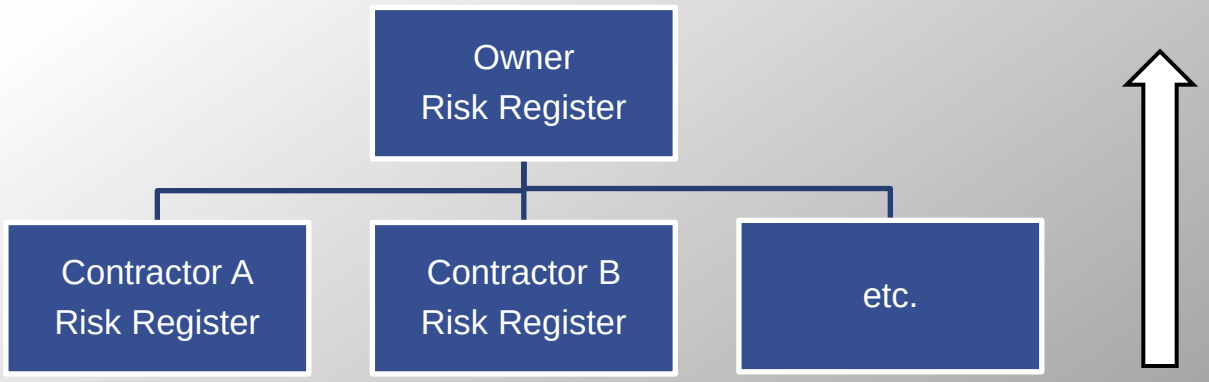
Top-Down Risk Management driven by Project Owner

- **Limited resources available for comprehensive and participative approaches (workshops perceived by managers as inefficient)**
- **Based on Lessons Learned, Checklists, SWOT**
- **A lot of the effort used in identifying Causes of Risks as Risks**
- **Project Risk Probabilities effectively assessed by considering**
  - **Previous experience of involved individuals**
  - **Risk Proximity**
  - **Risk Manageability**

Risk Management in Large Scale Pipeline Projects (2/5)

Bottom-Up Risk Management after Project Sanctioning

- **Transition between Define and Execute**
- **Instead of cascading Risk Control Requirements and so keeping the top-down structure, contractors start from scratch**



Risk Management in Large Scale Pipeline Projects (3/5)

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Project Risk Analysis established practice appears superficial

- **Risk Mitigation Strategies derived often seem just common sense,**
  - **e.g. „ensure proper…“**
- **Formulations used tend to be vague for those who have not been involved in an analysis > Records highly vulnerable to interpretation**
  - **Also influenced by concerns about who will read the reports**
- **Results are perceived as highly dependent on who is involved in the analysis**
- **Analysis efforts stop on a rather high-level, unless later it is identified that Risk Mitigation Strategies do not work**

Risk Management in Large Scale Pipeline Projects (4/5)

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Typical Risk Register Content

Risk Identification				Risk Analysis												Risk Mitigation		
Risk Description	Causes	Conse-quences	Risk Owner	HSSE &			Schedule			CAPEX			Integrity			Manage-ability	Mitigation Type	Risk Mitigation Strategy
				P	I	Risk	P	I	Risk	P	I	Risk	P	I	Risk			
Land Acquisition process delayed	Land requirements data not delivered by engineering	Delay in start of construction	Owner	N	N	N	M	H	H	M	H	H	N	N	N	Moderate	Avoid	Start identification of land owners on the basis of available land requirements information
Construction Contractors do not comply with ESIA Plans	Poor HSE culture	Breach in environmental regulations. Stop of Project activities. Fines	Contractor	M	M	M	M	L	M	M	L	M	N	N	N	Moderate	Reduce	Contractor prequalification processes. HSE training

Risk Management in Large Scale Pipeline Projects (5/5)

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Small impact on Contracts Development

- **Contracts built from „standard“ templates and project management requirements**
- **Communication of Project Risks sometimes deliberately avoided**
- **Focus is on liabilities**

Development of a Risk Mitigation Framework with STAMP (1/11)

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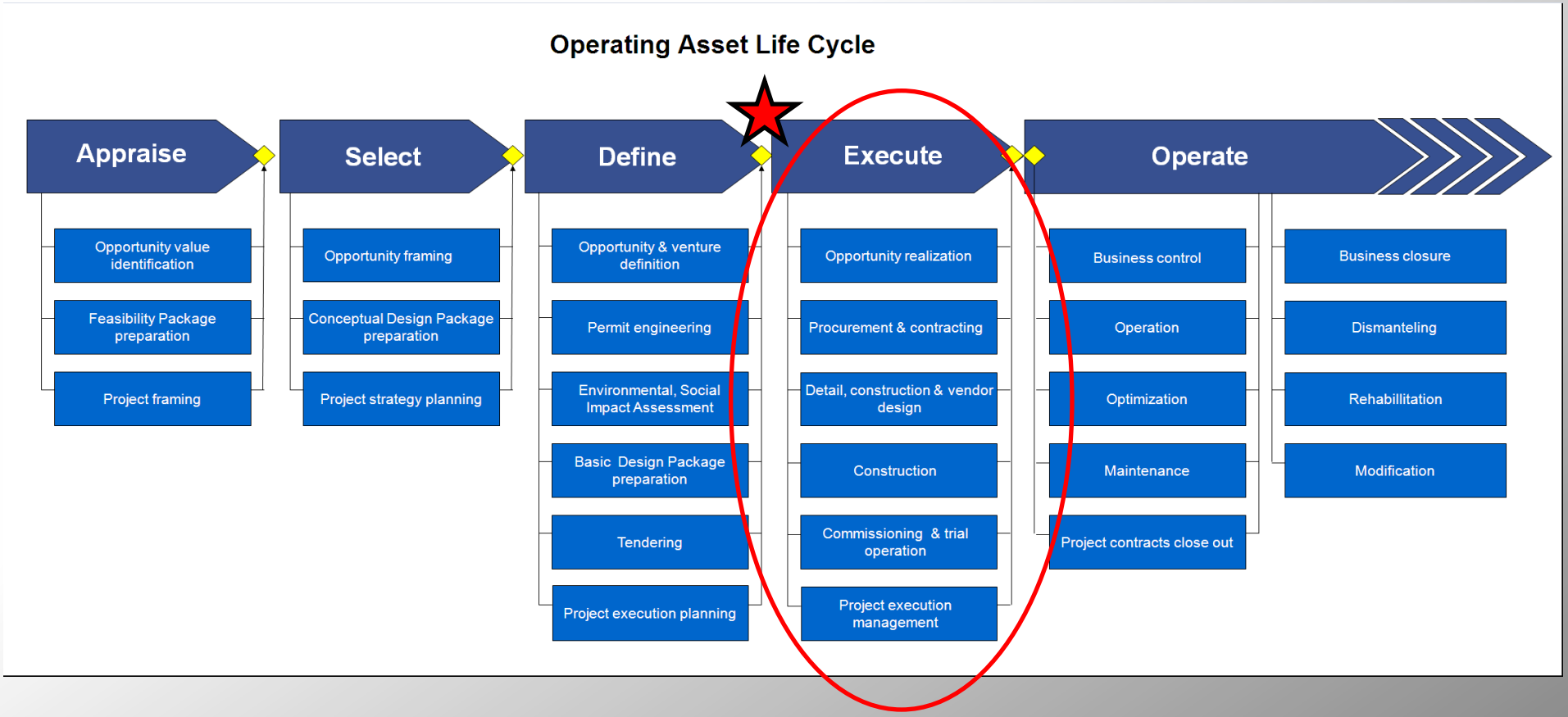
Scope



Development of a Risk Mitigation Framework with STAMP (2/11)

Typical Pipeline Project Goals

- *in STAMP terminology: defining Goals*

Project Design Goals

- **Deliver the Project to ensure target annual throughput**
- **Deliver the Project to enable safe pipeline operation**

Project Execution Goals

- **Deliver the Project in compliance with HSE regulations, norms and standards**
- **Deliver the Project without overruning sanctioned Project Budget**
- **Achieve Ready For Operation Target Date**

Development of a Risk Mitigation Framework with STAMP (3/11)

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Typical Unacceptable Project Losses (to be prevented)

- *in STAMP terminology: defining Accidents or Unacceptable Losses*

(Project) Operation Losses

- **Pipeline system does not deliver target annual throughput**
- **Major fire and/ or explosion during operations**

Project Execution Losses

- **Breach of HSE regulations, norms and standards**
- **Project Budget overrun**
- **Ready For Operation Target Date not achieved**

Development of a Risk Mitigation Framework with STAMP (4/11)

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Main Pipeline Project Risks (Limited Control by Project)

- *in STAMP terminology: Indetifying High-Level Hazards*

- **Geohazards along the pipeline route**
- **Weather conditions**
- **Archaeological finds along the pipeline route**
- **Steel and fuel price development**
- **Security threats**
- **Political and economic developments**

Development of a Risk Mitigation Framework with STAMP (5/11)

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Main Pipeline Project Risks (Control by Project)

- **Construction contractors do not perform as required during Project construction activities**
- **Damage to adjacent local infrastructure during Project construction activities**
- **Land acquisition is not completed when required to be handed over to construction contractors for start of related Project construction activities**
- **Authorities do not award permits to the Project when required for start of related Project construction activities *(partially controllable)***
- **Public opposition to the Project and its activities *(partially controllable)***
- **Line pipe and/ or other LLIs are not available when required to be used by construction contractors in the Project construction activities**
- **Major fire and/ or explosion during Project commissioning activities**

Development of a Risk Mitigation Framework with STAMP (6/11)

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- **Risk Mitigation Strategy**
  - *in STAMP terminology: deriving High-Level Safety Constraints*

- **Project Risk: Major fire and/ or explosion during Project commissioning activities**
  - **Risk Mitigation Strategy: Major fire and/ or explosion during Project commissioning activities must be prevented**

Development of a Risk Mitigation Framework with STAMP (7/11)

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- **Risk Mitigation Action Plan**
  - *in STAMP terminology: Generating High-Level Safety Requirements, Risk Control Actions*
- **Risk Mitigation Strategy: Major fire and/ or explosion during Project commissioning activities must be prevented**
  - **Plan sufficient time for Project Commissioning activities**
  - **Early involvement of Operations in the development of Project Commissioning plans and procedures**
    - **SPA > Owner – Operations Manager**
  - **Early and sufficient training of Contractors and Operations personnel in Project Commissioning plans and procedures**
  - **Close supervision of Project Commissioning activities**

STOP

Development of a Risk Mitigation Framework with STAMP (8/11)

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Potential Threats to Project Risk Mitigation Action Plan

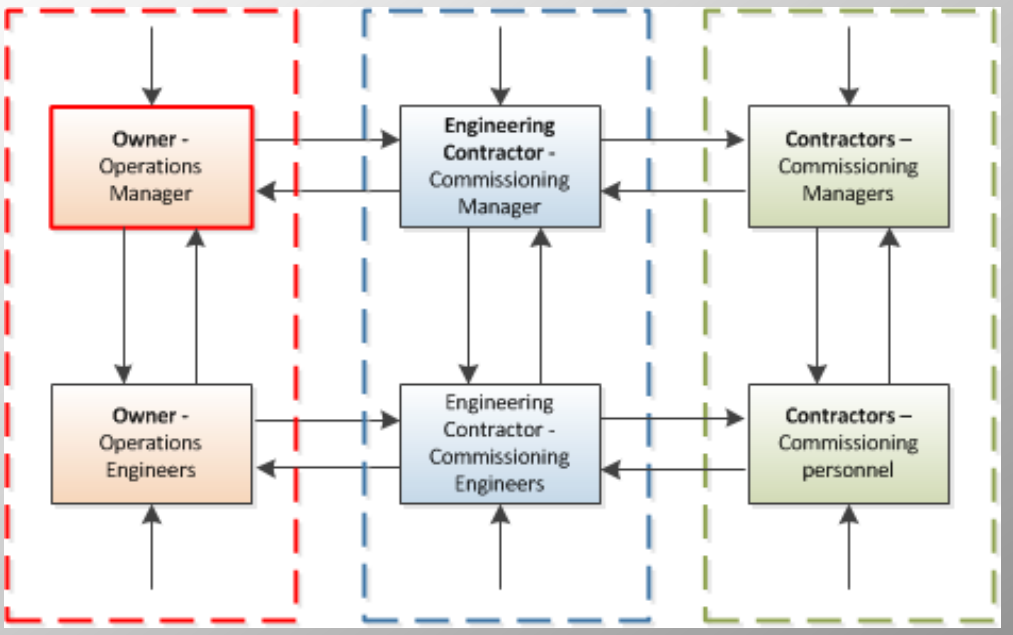
- *in STAMP terminology: STPA 1 Inadequate Control Actions*

Risk Mitigation Action: Early involvement of Operations in the development of Project Commissioning plans and procedures

- **Operations is not involved in the development of Project Commissioning plans and procedures.**
- **Operations is timely involved in the development of Project Commissioning plans and procedures, but their recommendations are incorrect.**
- **Operations is timely involved in the development of Project Commissioning plans and procedures, but their recommendations are ignored.**
- **Operations is involved in the development of Project Commissioning plans and procedures too late.**

Development of a Risk Mitigation Framework with STAMP (9/11)

- **Detail Partial Project Execution Structure**
- **Risk Mitigation Action: Early involvement of Operations in the development of Project Commissioning plans and procedures**
- **SPA Owner – Operations Manager**
- **Roles & Responsibilities**
- **Multiple controllers**



Development of a Risk Mitigation Framework with STAMP (10/11)

■ Potential Causes of Threats to Project Risk Mitigation Action Plan

➢ *in STAMP terminology: STPA 2 Causes of Inadequate Control Actions*

RMA.ACCIDENT.2

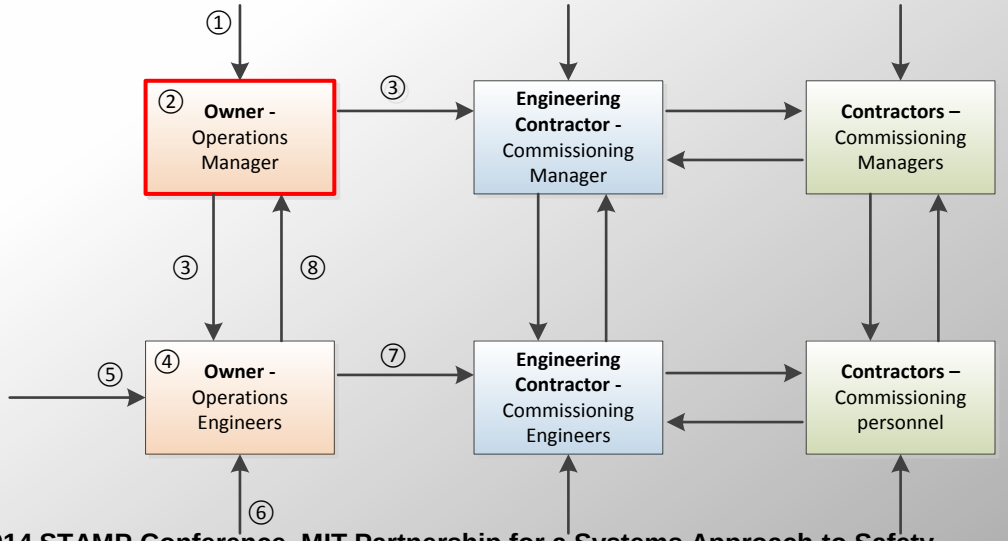
Early involvement of Operations in the development of Project Commissioning plans and procedures

ICA.ACCIDENT.2.1 - Operations is not involved in the development of Project Commissioning plans and procedures.

ICA.ACCIDENT.2.2 - Operations is timely involved in the development of Project Commissioning plans and procedures, but their recommendations are ignored.

ICA.ACCIDENT.2.3 - Operations is timely involved in the development of Project Commissioning plans and procedures, but their recommendations are incorrect.

ICA.ACCIDENT.2.4 - Operations is involved in the development of Project Commissioning plans and procedures too late.



① Control input or external information wrong or missing

② Inadequate control algorithm (flaws in creation, process changes, incorrect modification or adaption) and/ or

Process Model inconsistent, incomplete or incorrect

③ Inapproriate, ineffective or missing control action and/ or Operation delays

④ Component failures, changes over time

⑤ Conflicting control actions

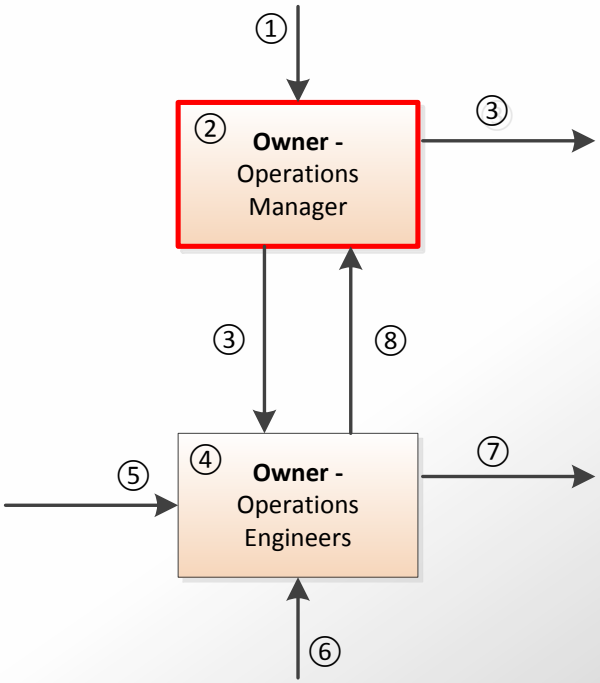
⑥ Unidentified or out-of-range disturbance

⑦ Process output contributes to system hazard

⑧ Incorrect or no feedback information provided and/ or Feedback delays

Development of a Risk Mitigation Framework with STAMP (11/11)

Potential Causes of Threats to Project Risk Mitigation Action Plan



1.1	Allocation of resources for start of involvement of Owner's Operations personnel is not provided by Owner's management
1.2	Incorrectly scheduled involvement of Owner's Operations personnel in Project Schedule
2.1	Incorrect understanding of scope and extent of development of Project Commissioning plans and procedures
2.2	Too optimistic estimation of Operations Engineer manhours required in development of Project Commissioning plans and procedures
2.3	Incorrect definition of required competence for Operations Engineers involvement in development of Project Commissioning plans and procedures
3.1	Late provision of instruction for Operations Engineers to start alignment with Engineering Contractor's Commissioning Engineers
3.2	Late provision of instruction to Engineering Contractor's Commissioninf Manager for start of alignment between Owner's Operations Engineers and Engineering Contractor's Commissioning Engineers
4.1	Operations Engineers are not available when required start of alignment with Engineering Contractor's Commissioning Engineers
4.2	Operations Engineers are replaced during initial development of Project Commissioning plans and procedures
5.1	Operations Director requires support of Operations Engineers in another task in the same time frame
7.1	Incorrect advise is provided to Engineering Contractor's Commissioning Engineers
7.2	Correct advise provided to Engineering Contractor's Commissioning Engineers is not considered
8.1	Operations Engineers report start of alignment with Engineering Contractor's Commissioning Engineers, but effectively it has not started
8.2	Operations Engineers report start of alignment with Engineering Contractor's Commissioning Engineers too late

Evaluation (1/3)

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- **Comparison development of Risk Mitigation Strategies**
- **Risk Management Planning phase similar**
  - **Defining Goals, Risk Matrix approach vs. Defining Unacceptable Losses, Roles and Responsibilities**
- **STAMP framework more structured**
  - **Clear development: Goals > Losses > H-L Hazards > H-L Constraints/ Reqs.**
  - **Appears to be less dependent on who is involved in the Project Risk Analysis**
  - **Traceability straightforward, rationale readily available**
- **Identified ICAs and causes of ICAs in the example are credible**
- **More detailed and precise Risk Mitigation Strategies (requirements) can be derived with STPA**

Evaluation (2/3)

- **Integration of STAMP into regular Project Risk Management (1/2)**
- **Introducing different levels of Project Risks/ Risk Mitigation Reqs**
  - **Similarly System Hazards/ Sys reqs ↔ Lower Level Hazards/ Lower Level reqs**
- **STPA can be used in development of Risk Mitigation Strategies**
  - **Short term > In ongoing projects**
    - **Use in Risk Monitoring and Risk Review**
  - **Long Term > Development/ Improvement of**
    - **Project Management standards (e.g. requirements, but also as checklists)**
    - **Contracts**
- **STPA can be used independently by an analyst with knowledge of techniques and Project context**

Evaluation (3/3)

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Integration of STAMP into regular Project Risk Management (2/2)

Regular Risk Management	STAMP-based Risk Management
Risk Management Planning	Goals, Unacceptable Losses, Safety Control Structure
Risk Identification and Analysis	High-Level Hazards
Risk Mitigation Strategy	High-Level Safety Constraints
Risk Mitigation Action Plans	High-Level Safety Requirements, Control Actions
Risk Tracking and Review	STPA Step 1 Unsafe Control Actions STPA Step 2 Causes of UCAs

More Information

MIT Partnership for a Systems Approach to Safety

- Papers, Masters Theses and Ph.D. Dissertations

References: Helferich, Samedi

http://psas.scripts.mit.edu/home/theses-and-dissertations/

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2nd European STAMP Conference (22-23 Sept 2014 @ Uni Stuttgart)

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22.- 23. September 2014, Stuttgart, Germany
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