

# SoSECIE Webinar

Welcome to the  
2021 System of Systems Engineering Collaborators  
Information Exchange (SoSECIE)



*We will start at 11AM Eastern Time*

*You can download today's presentation from the SoSECIE Website:*

*<https://mitre.tahoe.appsembler.com/blog>*

*To add/remove yourself from the email list or suggest a future topic or speaker, send an email to [sosecie@mitre.org](mailto:sosecie@mitre.org)*

# NDIA System of Systems SE Committee

- **Mission**

- To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
- To identify successful strategies for applying systems engineering principles to systems engineering of SoS

- **Operating Practices**

- Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

# Join us for the NDIA's Virtual Systems and Mission Engineering Conference

*Dates: Monday, December 6<sup>th</sup> through Wednesday, December 8<sup>th</sup>*

- **Why Attend?**

- Gain insight on improving acquisition and performance of defense programs and systems.
- Hear from Program Managers, Systems Engineers, Chief Scientists, and Engineers and Managers.
- Participate in Q&As with session speakers; getting your most pressing systems engineering questions answered.
- View handouts to supplement and enhance your virtual experience.
- Network and build relationships with like-minded professionals during virtual networking opportunities.

- **Topics**

- Engineering and Manufacturing
- Human Systems Integration
- Systems Architecture
- Systems Security Engineering
- Systems of Systems Engineering

*Register online at*

*<https://www.ndia.org/events/2021/12/6/24th-sme-conference-virtual/registration>*

# Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at [sosecie@mitre.org](mailto:sosecie@mitre.org).
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Teams.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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# **2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars**

*Sponsored by MITRE and NDIA SE Division*

***November 16, 2021***

***A Design Method for Collaborative Systems of Systems Applied to Metropolitan Multi-Mode  
Transport System***

*Pontus Svenson, Frida Reichenberg, and Jakob Axelsson*

***November 30, 2021***

***Should I Stay or Should I Go? How Constituent Systems Decide to Join or Leave Constellations in  
Collaborative SoS***

*Pontus Svenson and Jakob Axelsson*

***December 14, 2021***

***A Heterogeneous Autonomous Collaborative System for Powerline Inspection Using Human-Robotic  
Teaming***

*Srikanth Vemula, Jovany Avila, and Michael Frye*

***January 11, 2022***

***Approach for Complex Deterministic and Nondeterministic Systems (ACDANS)***

*Dr. Paul C. Hershey*

***January 25, 2022***

***Applying SoSE in Healthcare: the case for a soft systems methodology approach to Digital-first  
Primary Care***

*Iqra Shahzad, Melanie King, and Michael Henshaw*

# **2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars**

*Sponsored by MITRE and NDIA SE Division*

*February 8, 2022*

*Empowering Adaptive Human Autonomy Collaboration (DUAL) with Artificial Intelligence  
Dr. Mark Chattington*

*February 22, 2022*

*System of Systems Engineering Conference (SoSE) and Industry Perspectives and the Role of SoSE:  
INCOSE and IEEE Collaborations  
Paul Hershey, Garry Roedler, and Mo Jamshidi*

*March 8, 2022*

*An Event-based Microservice Platform for Autonomous Cyber-Physical Systems: the case of Smart  
Farming  
Mara Nikolaidou*

*May 3, 2022*

*Cross-Domain Stakeholder-Alignment in Collaborative SoS – Lego Serious Play as a Boundary Object  
Johann Shuetz, Julia Koehlke, and Sebastian Hanna*

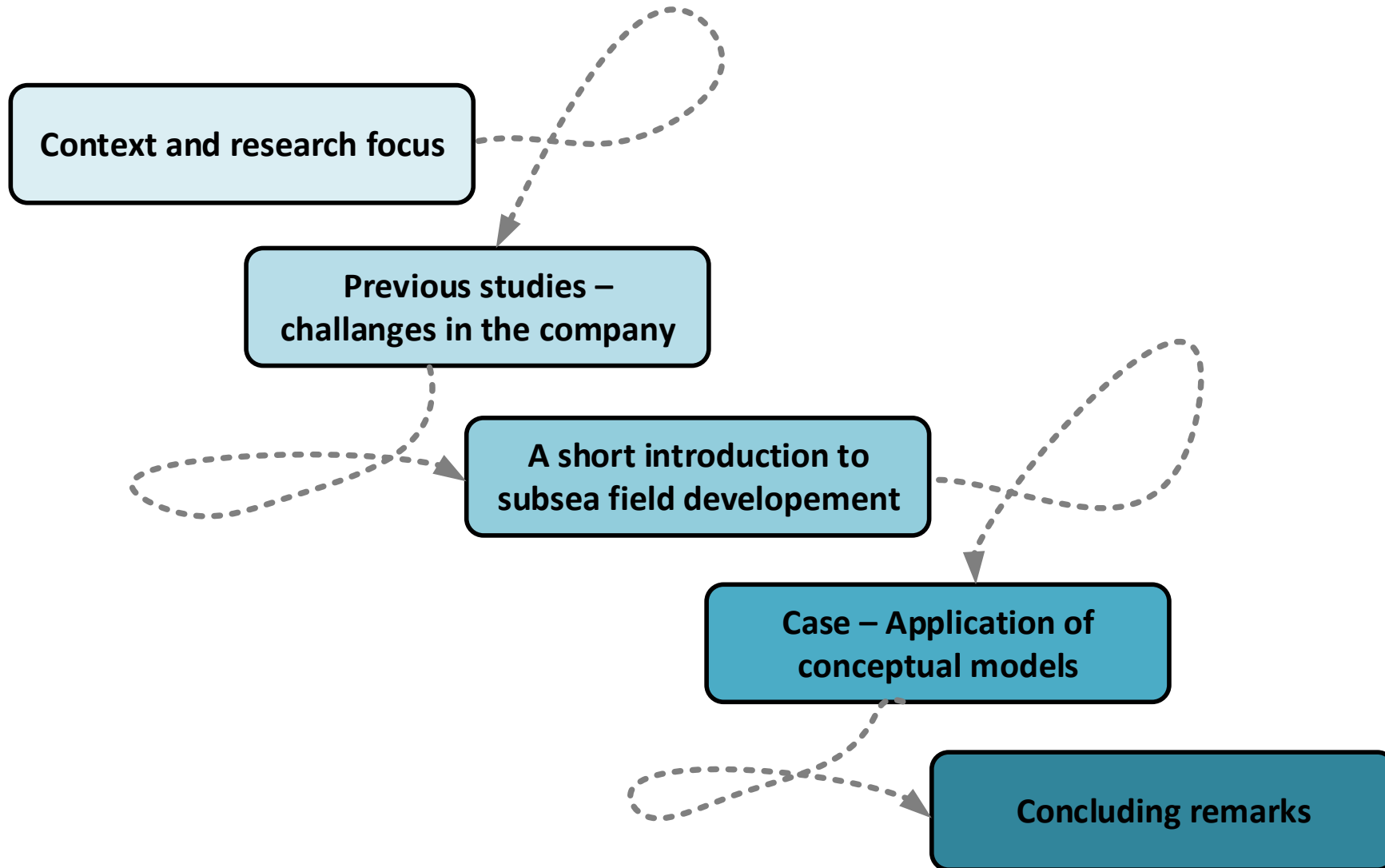
# Conceptual Models to Support Reasoning in Early-phase Concept Evaluation - a Subsea Case Study

**Presenter:** Siv Engen

**Co-authors:** Kristin Falk and Gerrit Muller



# Outline

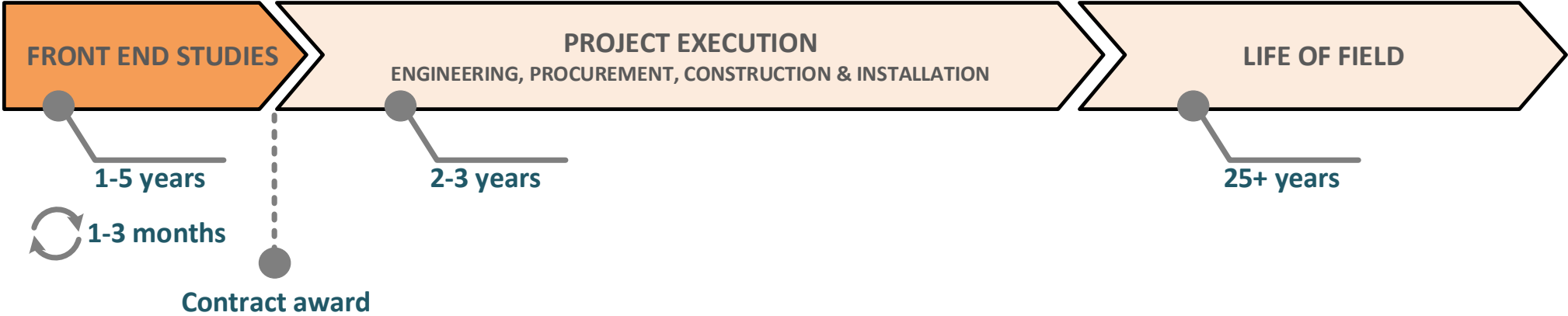


# Context - the subsea field development study

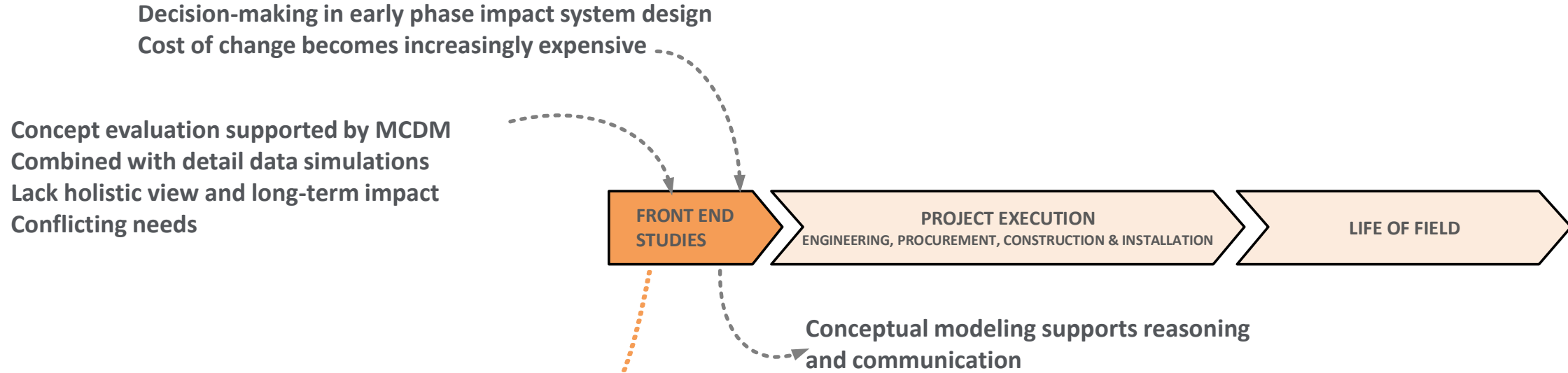
OPERATOR VIEW



SYSTEM SUPPLIER VIEW



# Context and research focus



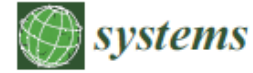
- Conceptual models to support balancing conflicting needs
- Reasoning of life-cycle impact
- Focus modeling effort where it matters the most

“**Conceptual models** are models that are sufficiently simplified to help architects to understand, reason, communicate and make decisions”

# Systems Awareness – a study from the energy industry



## Qualitative study in company

- Semi-structured interviews
- Questionnaire to 126 systems engineers and sub-systems engineers
- Study of technical documentation
- Observation and active participation



Article

## The Need for Systems Awareness to Support Early-Phase Decision-Making—A Study from the Norwegian Energy Industry

Siv Engen <sup>\*</sup>, Kristin Falk and Gerrit Muller 

Faculty of Technology, Natural Sciences and Maritime Sciences, University of South-Eastern Norway, 3610 Kongsberg, Norway; kristin.falk@usn.no (K.F.); gerrit.muller@usn.no (G.M.)

\* Correspondence: siv.engen@usn.no

**Abstract:** In this paper, we explore the need to improve systems awareness to support early-phase decision-making. This research uses the Norwegian energy industry as context. This industry deals with highly complex engineering systems that shall operate remotely for 25+ years. Through an in-depth study in a systems supplier company, we find that engineers are not sufficiently aware of the systems operational context and do not focus on the context in the early phase. We identified the lack of a holistic mindset and the challenge of balancing internal strategy and customers' needs as the prevalent barriers. To support the concept evaluation, the subsea system suppliers need to raise systems awareness in the early phase. The study identifies four aspects that are important to consider when developing and implementing approaches to improve systems awareness in the early phase.

# Findings – Awareness of system context

## System context:

- Understand the context
- Less confident in understanding the interactions with other systems in operation
- Lack focus on the installation and operational scenarios
- Lack focus on the system context

## Key drivers:

- Lack focus of the key drivers
- Not sufficient understanding of how the key drivers affect the system design

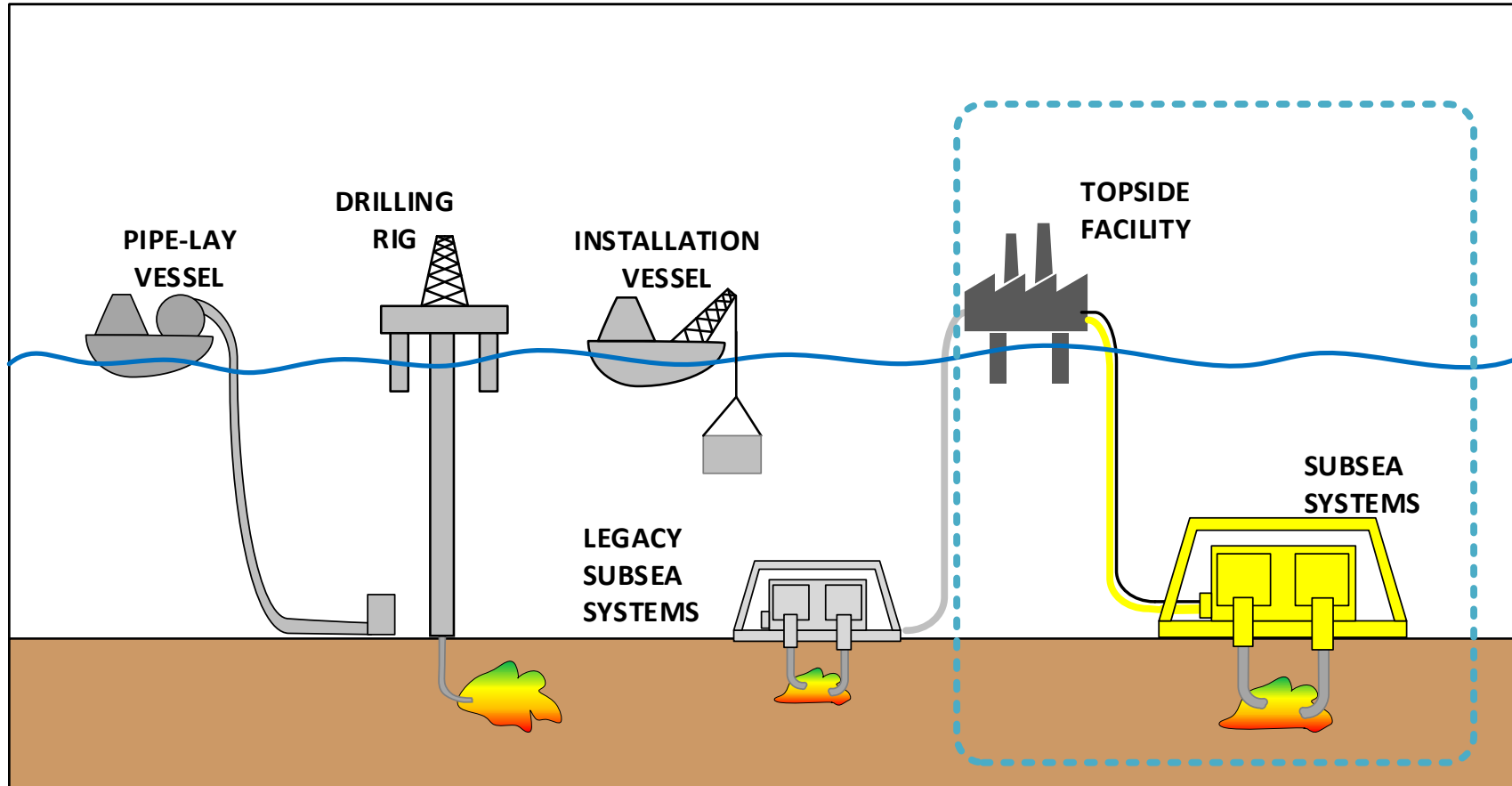
## Barriers:

- Lack of a holistic mindset
- Challenge of balancing internal strategy and customers' needs
- Lack of knowledge of the overall system

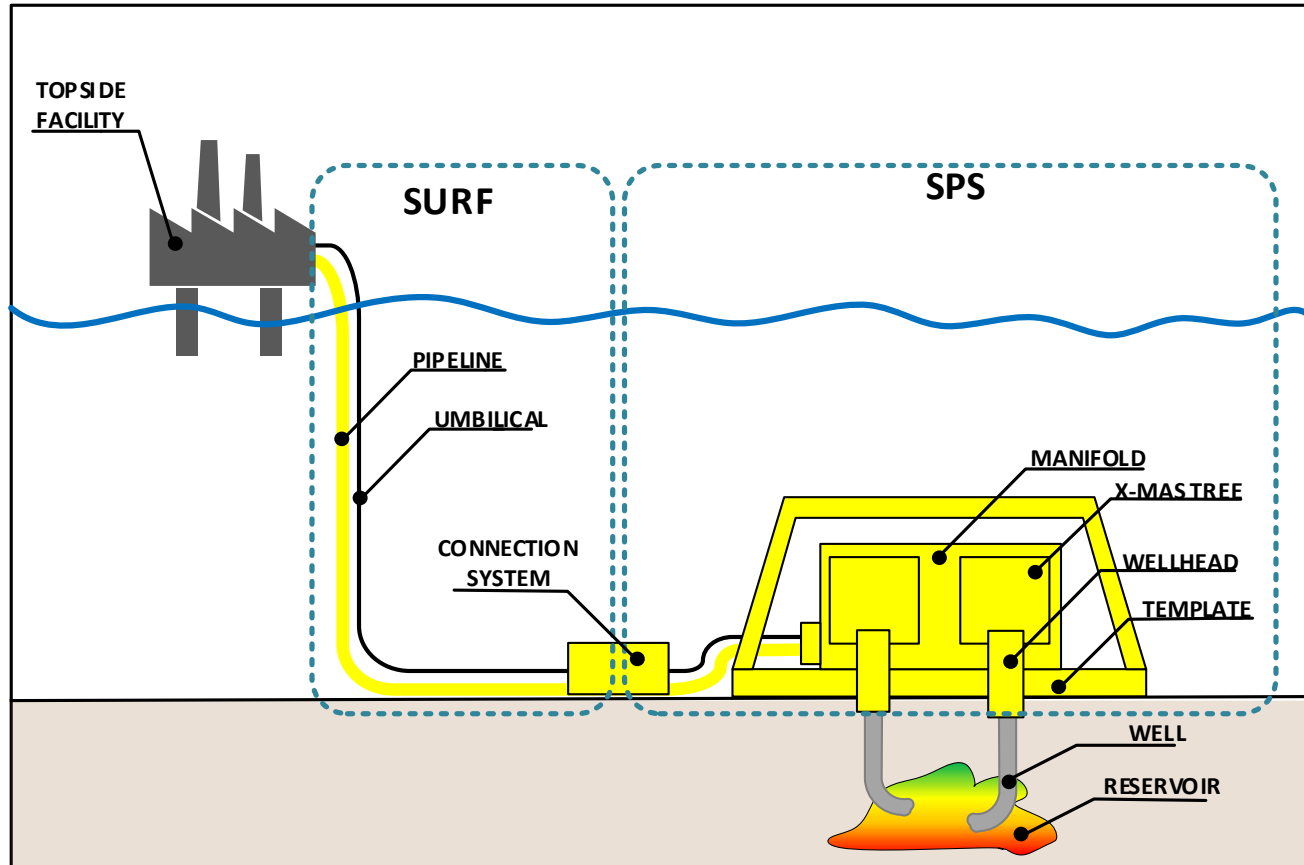
## Aspect to consider:

- Limited use of resources
- Adaptability
- Low threshold of use
- Communicating to a diverse group of stakeholders

# Introduction to a subsea field development problem



# Introduction to a subsea field development problem



**SPS**

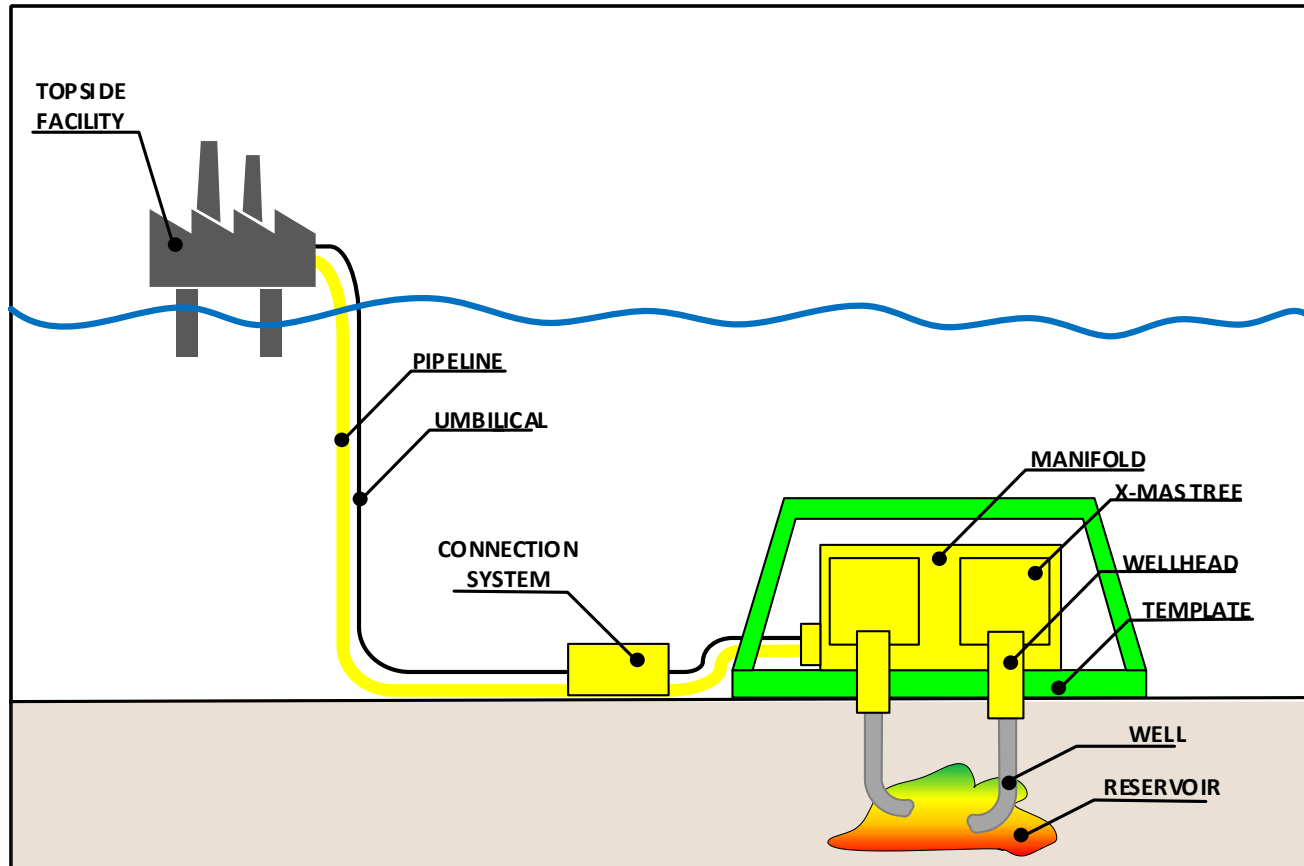
**Subsea Production System**

**SURF**

**Subsea umbilicals, risers and flowlines**

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# Introduction to a subsea field development problem



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## Subsea Production System

### Wellhead

a pressure-containing interface between the well and the X-mas tree

### X-mas tree

an assembly of valves and piping, which acts as and pressure barrier between the well and the environment.

### Manifold

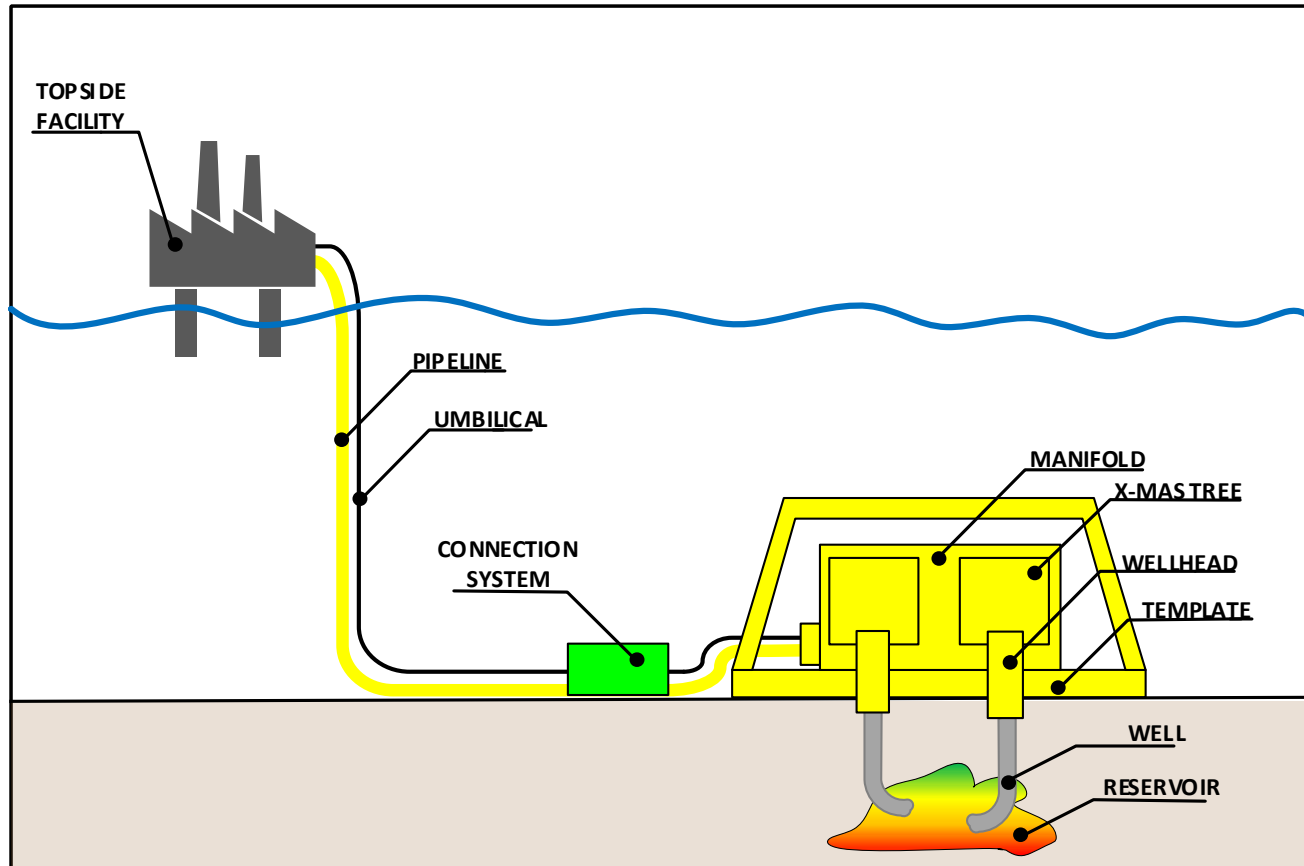
an block with valves and piping, which collects, handles, and distributes production fluids from several wells.

### Template

a structure which provides foundation and protection



# Introduction to a subsea field development problem



## Subsea umbilical, risers and flowlines

### Umbilical

electrical signals, chemicals, and hydraulic services between subsea production system and topside facility

### Flowlines

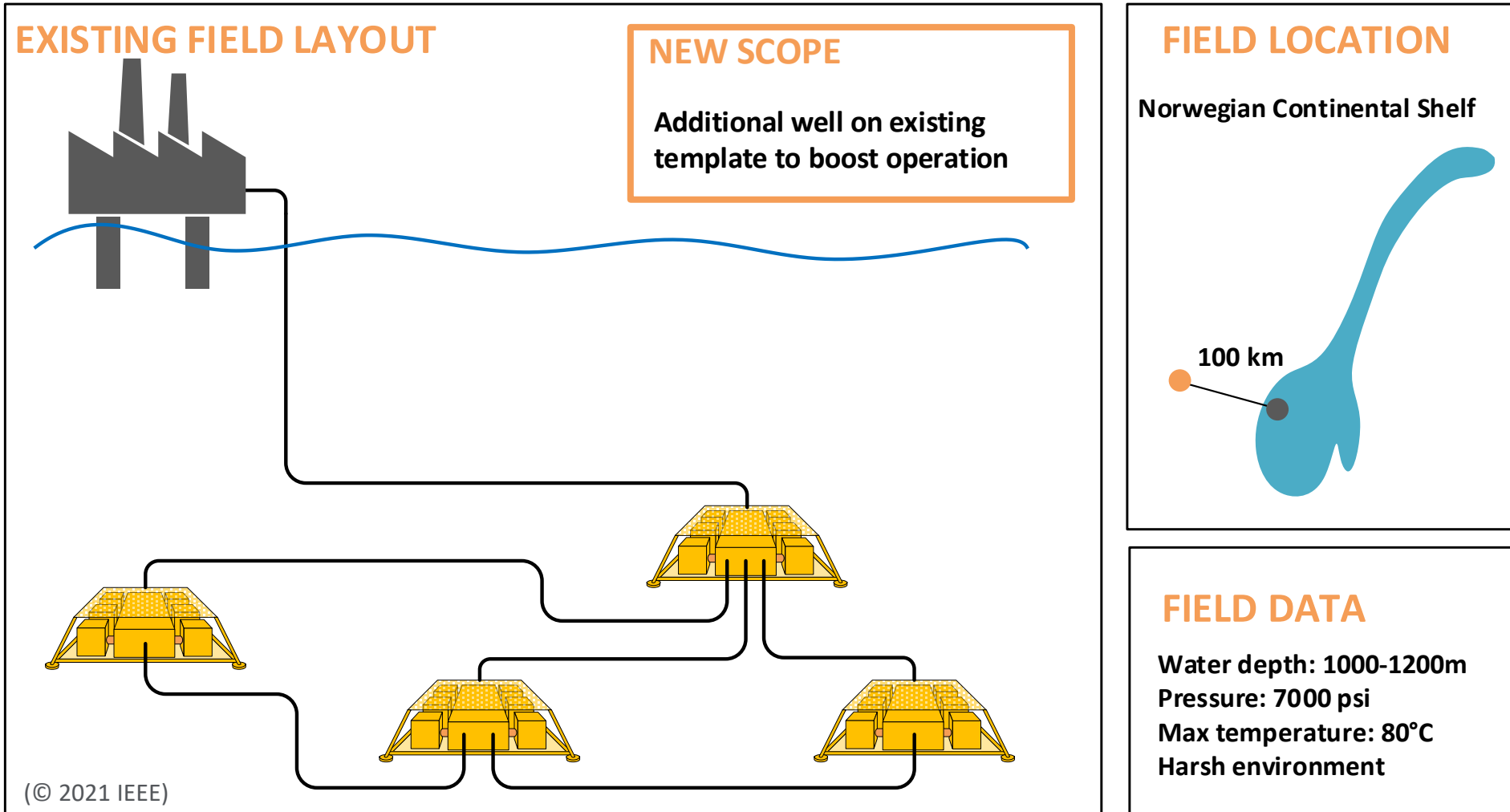
transport production fluids from and injections fluids to the subsea production system

## Interface

### Connection system

interface between SURF and subsea production system, provides tie-in and connection

# The case – Dolly field



**Reference:** Engen S, Falk K, Muller G. Conceptual Models to Support Reasoning in Early Phase Concept Evaluation - a Subsea Case Study. In: 16th International Conference of System of Systems Engineering (SoSE). IEEE; 2021:95-101. doi:10.1109/

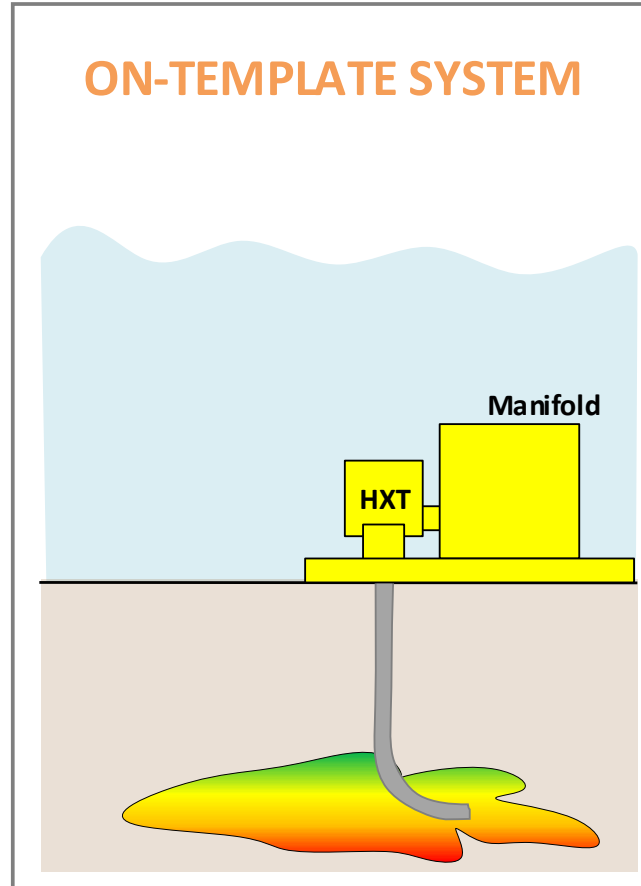
# The case – alternative concepts

## Horizontal X-mas tree

XT must be installed before the well can be completed

Installed on template

Existing solution at field



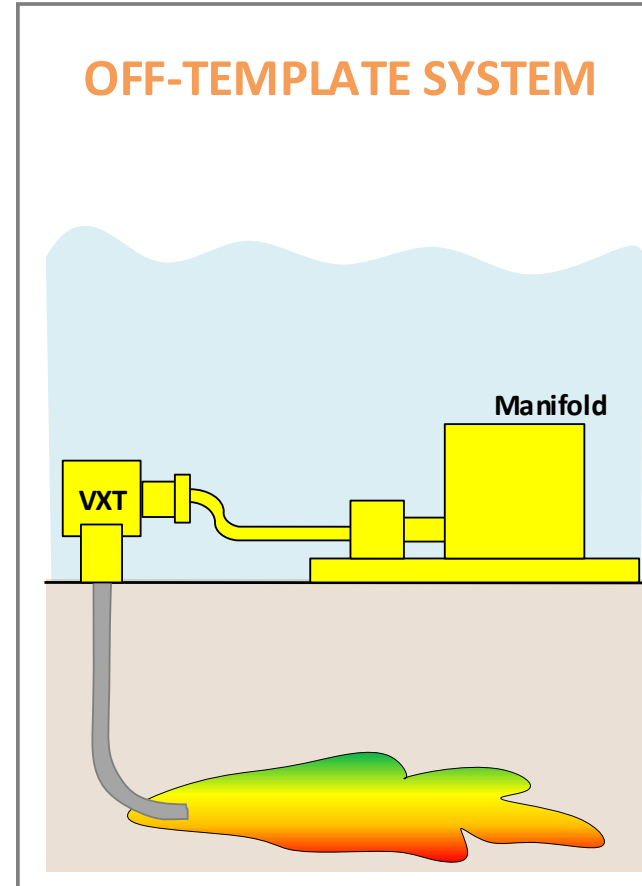
## OFF-TEMPLATE SYSTEM

## Vertical X-mas tree

Can complete well before XT is installed

Install off template

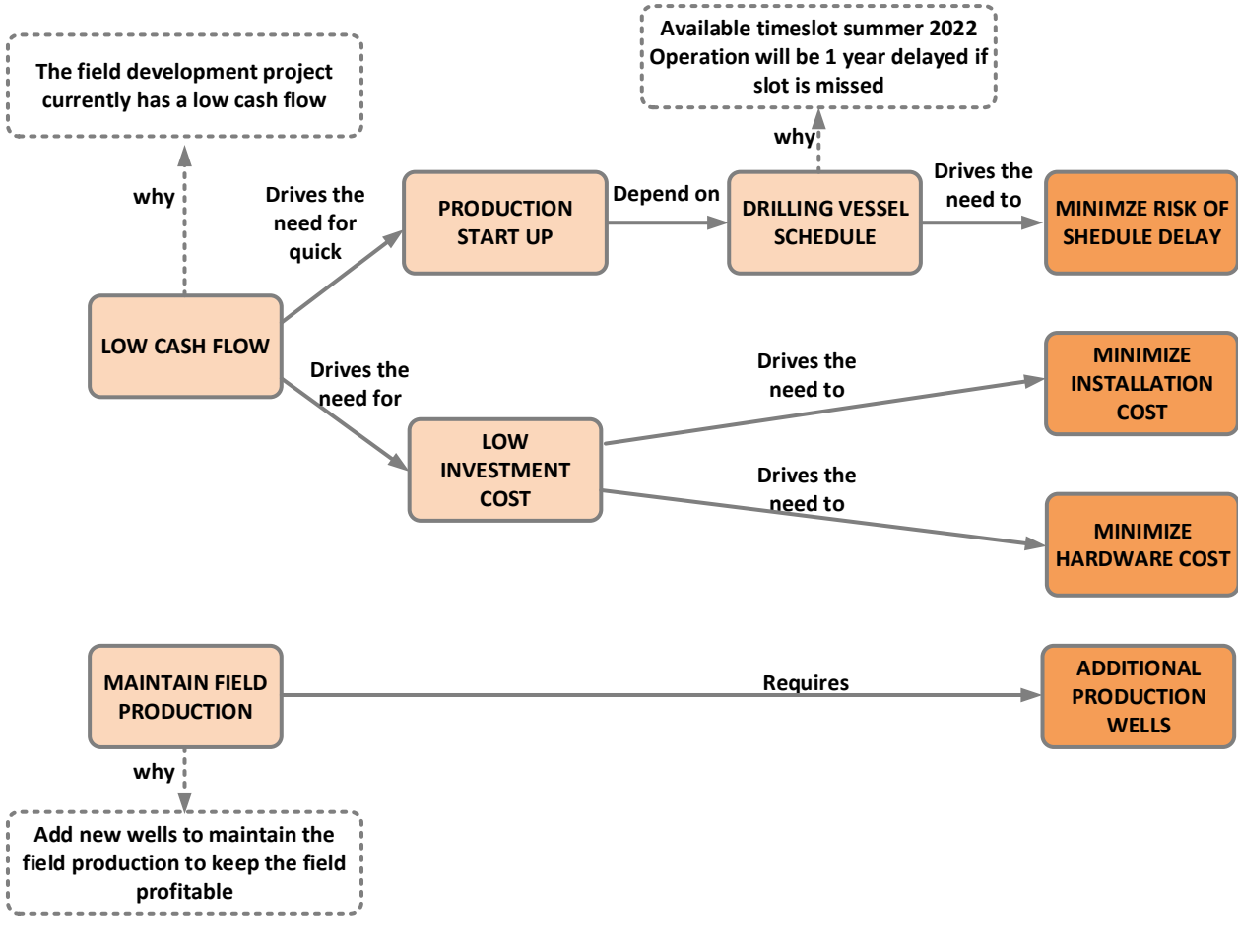
Company's low cost solution



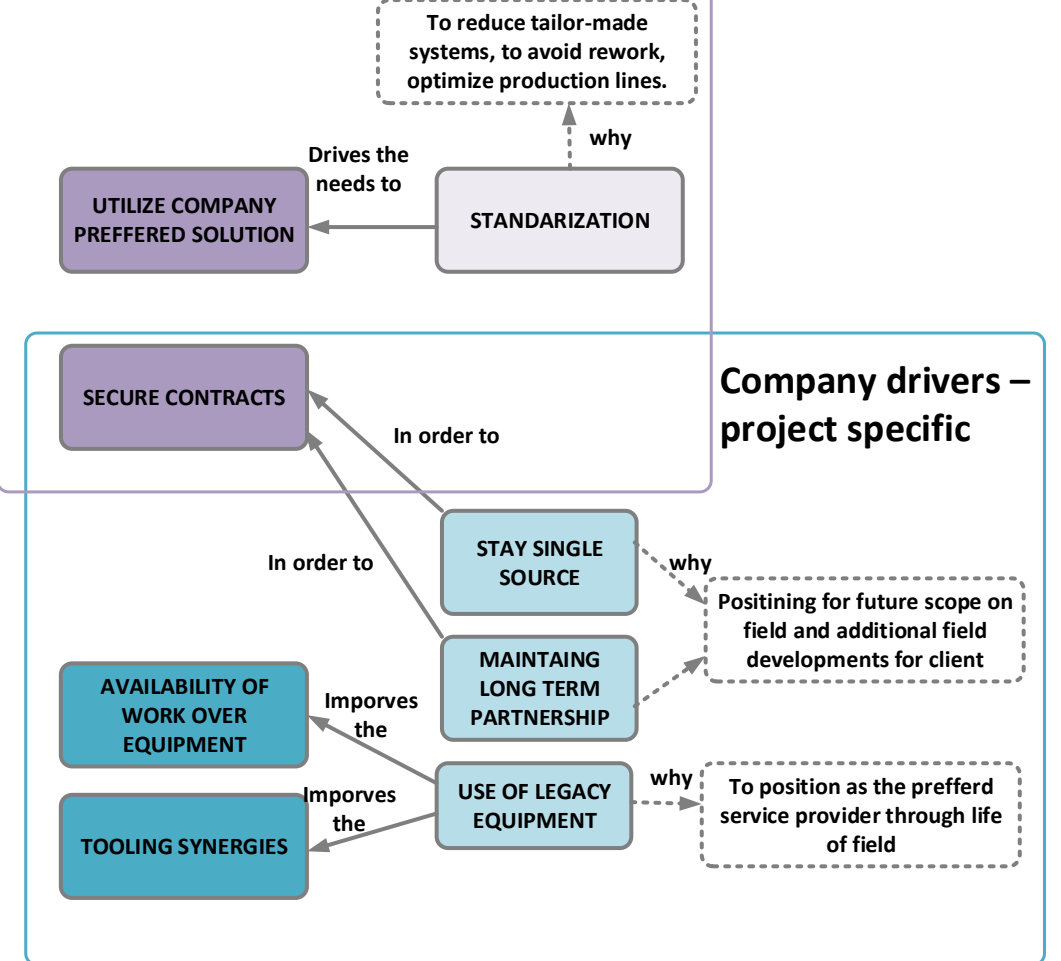
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# The case - mapping of key drivers

## Customer drivers



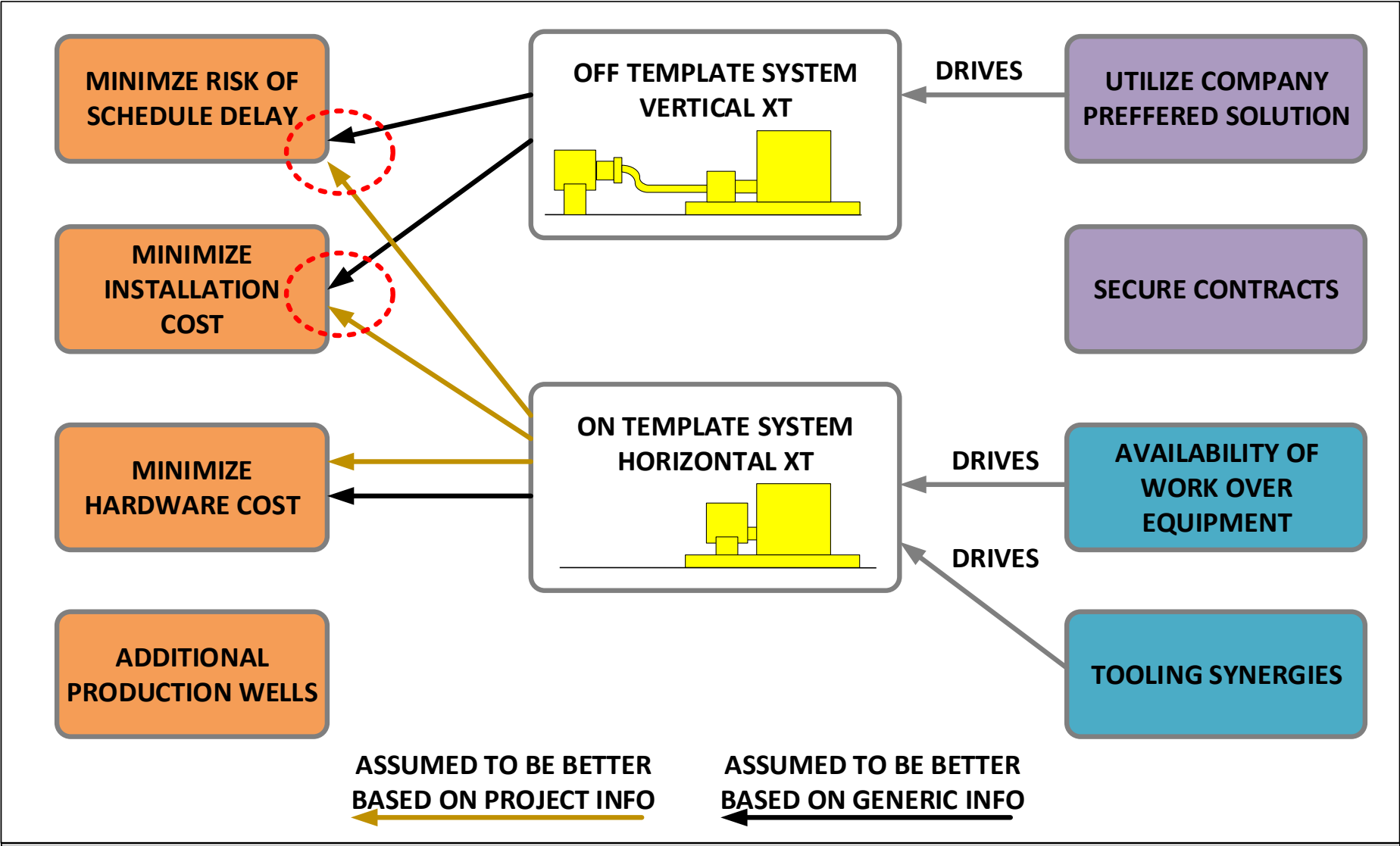
## Company drivers – overall



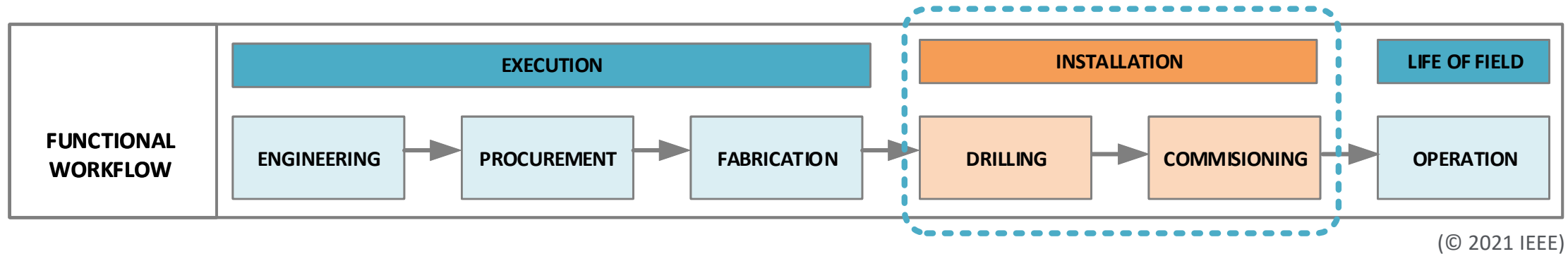
## Legends



# The case – identification of tensions and issues

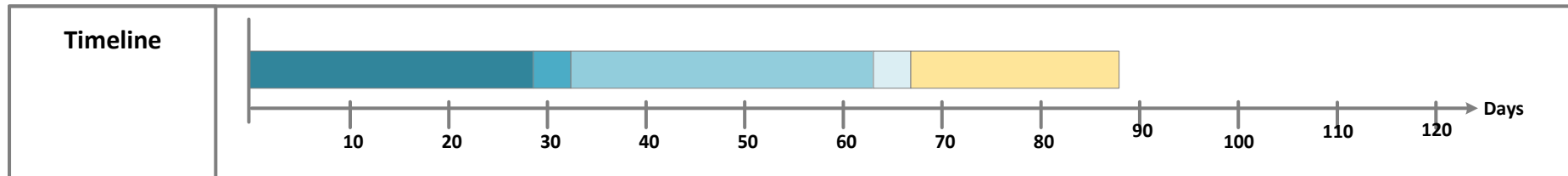
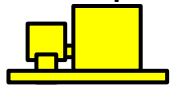


# The case – conceptual models - overall

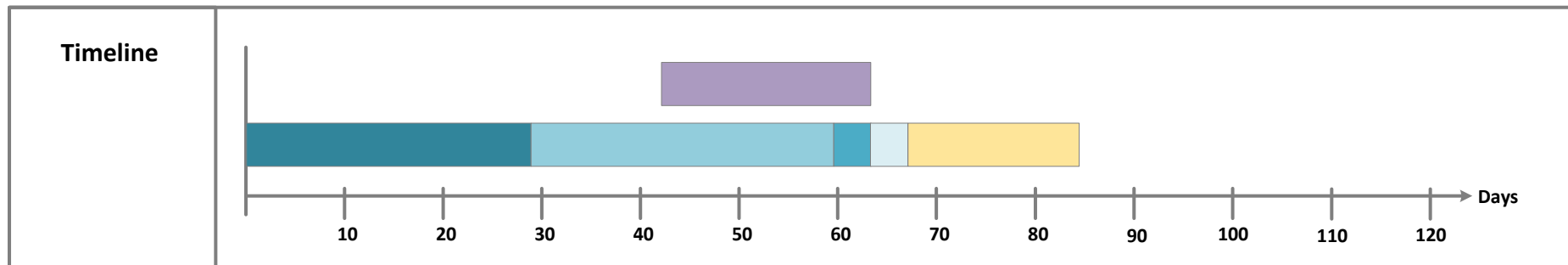
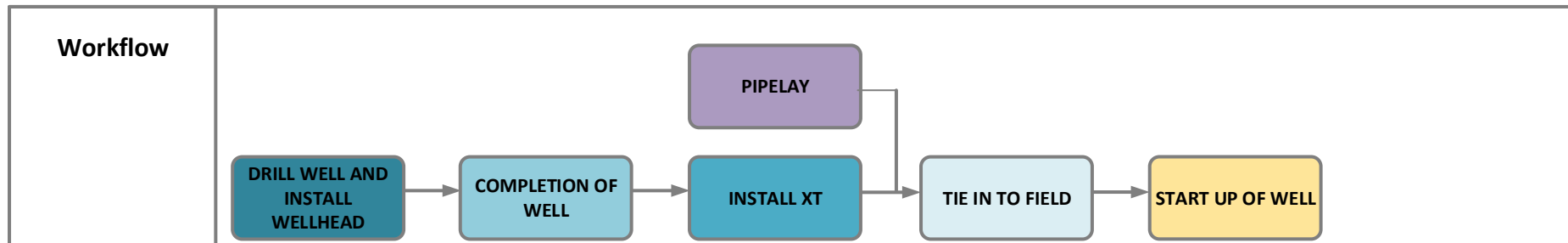
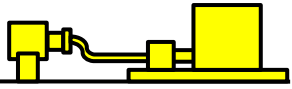


# The case – conceptual models – generic knowledge

Concept: on-template



Concept: off-template

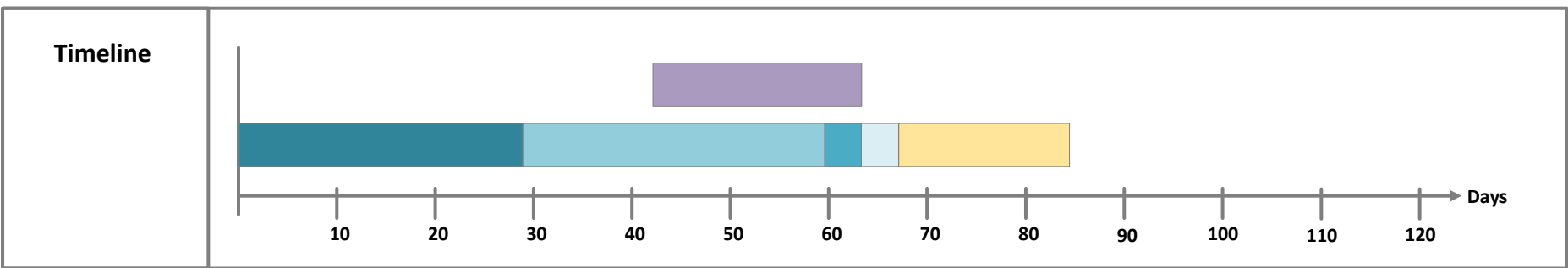
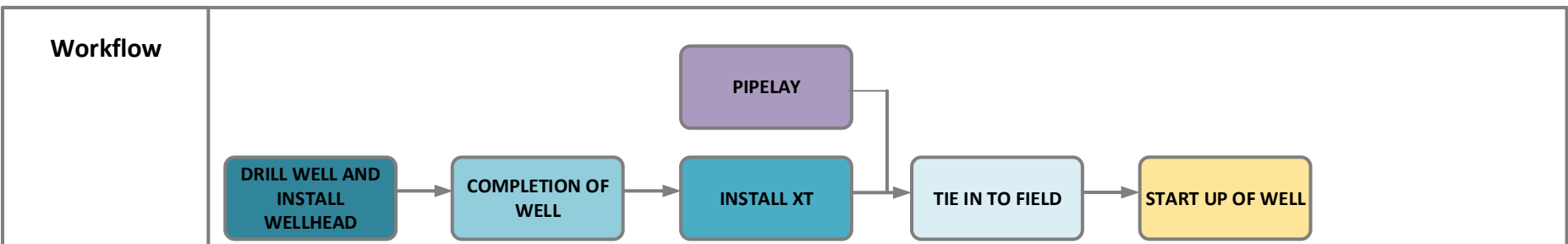
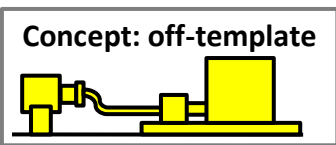
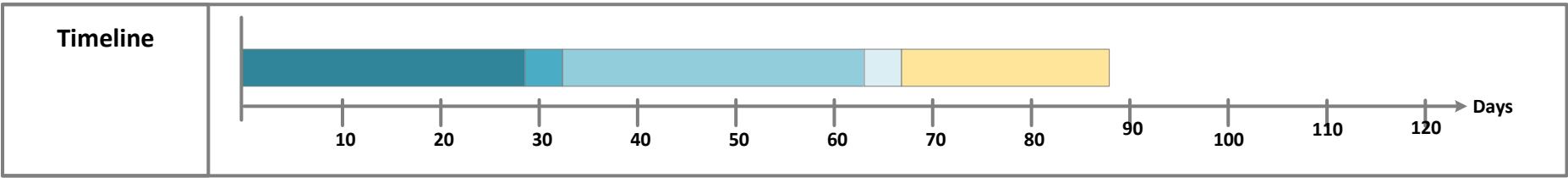
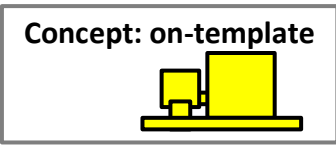


# The case – conceptual models – project knowledge

MITIGATION BY USE OF SPARES

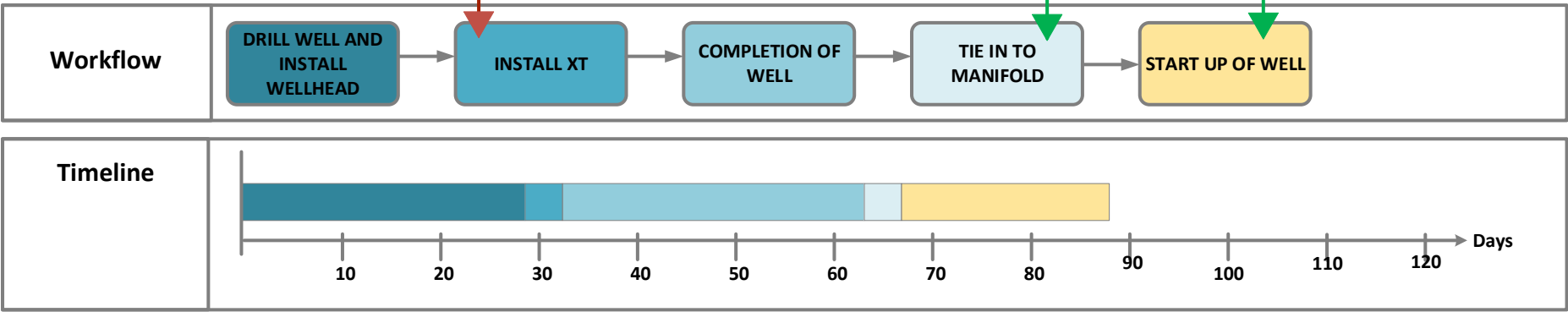
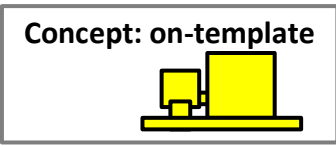
TOOLING AND WORKOVER EQUIPMENT AVAILABLE

XT MUST BE AVAILABLE BEFORE COMPLETION OF THE WELL





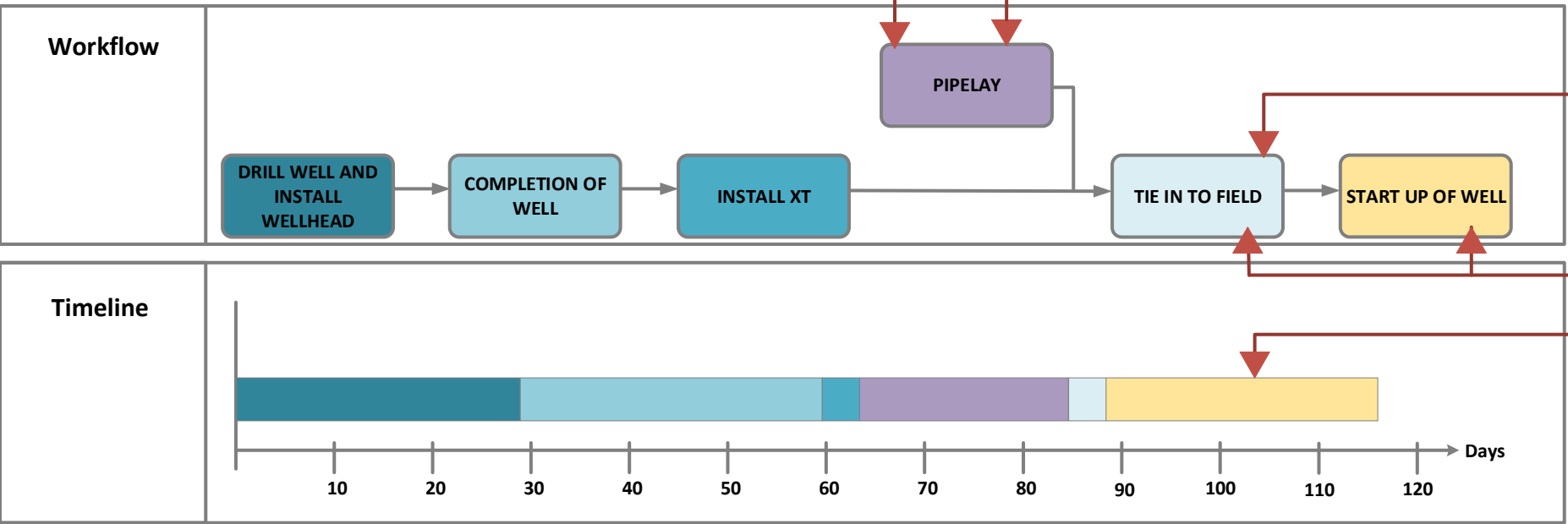
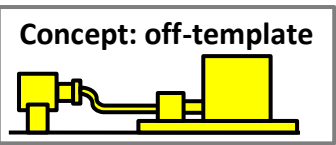
# The case – conceptual models – project knowledge



MITIGATION BY USE OF SPARES

TOOLING AND WORKOVER EQUIPMENT AVAILABLE

XT MUST BE AVAILABLE BEFORE COMPLETION OF THE WELL



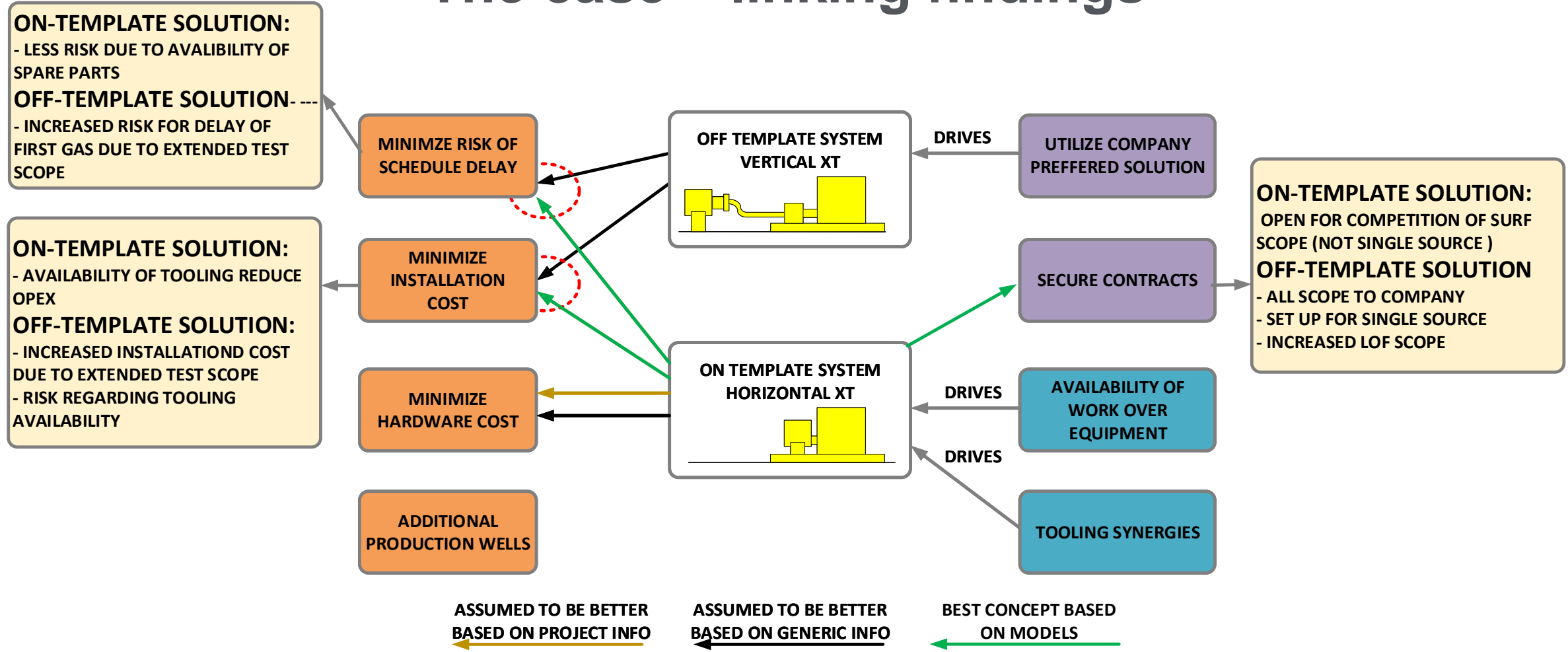
POTENTIAL FOR SIMOPS, BUT NOT AVAILABLE DUE TO DISTANCE

COMPTITION OF SCOPE

UNCERTAINTY OF TOOLING AND WORKOVER EQUIPMENT AVAILABLE

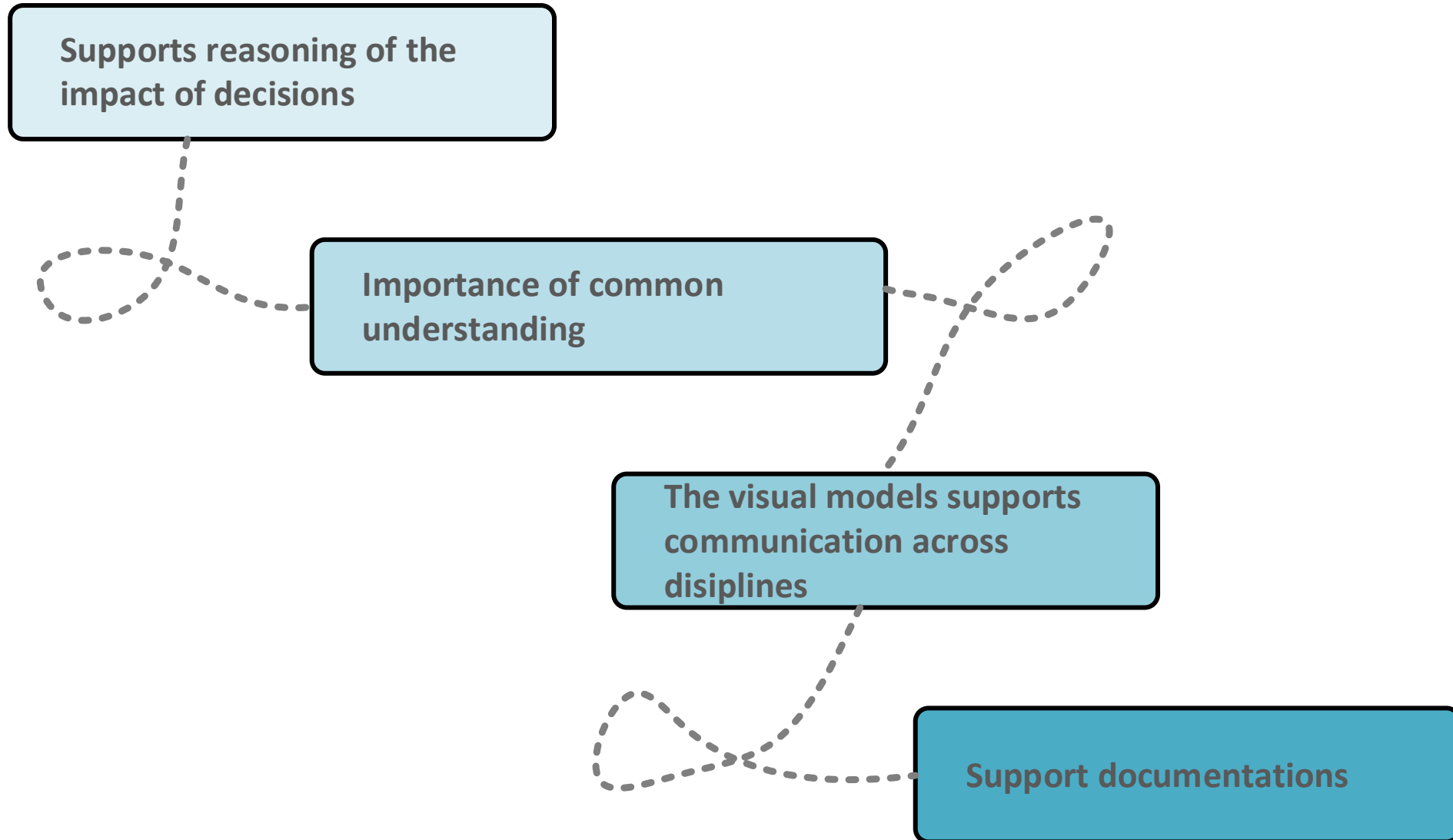
ADDITIONAL TEST SCOPE

# The case – linking findings

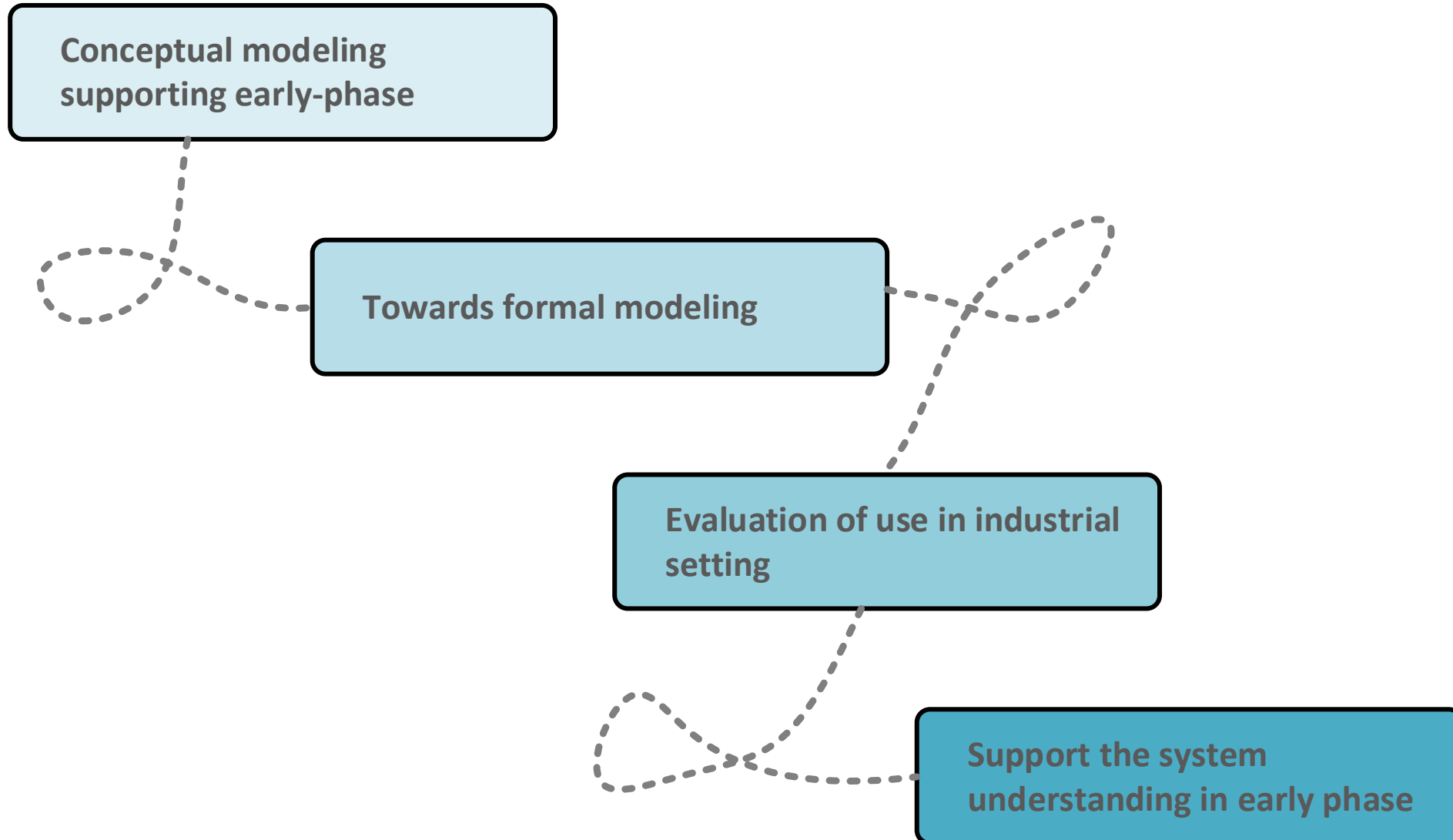


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# Insights from the case



# Conclusion and further work



**Thank you for your attention**