31st Annual INCOSE international symposium

virtual event

July 17 - 22, 2021

A case study

Application of A3AO in subsea

www.incose.org/symp2021

Authors

Remi Haugland

Mechanical Engineer

Master of Science in Systems Engineering, 2020

University of South-Eastern Norway

Siv Engen

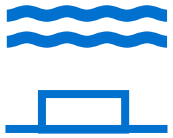
Industrial Ph.D. Candidate,

University of South-Eastern Norway

Master of Technologies, Engineering Science and ICT, 2008

Norway University of Science and Technology

Outline



Introduction to the subsea field development

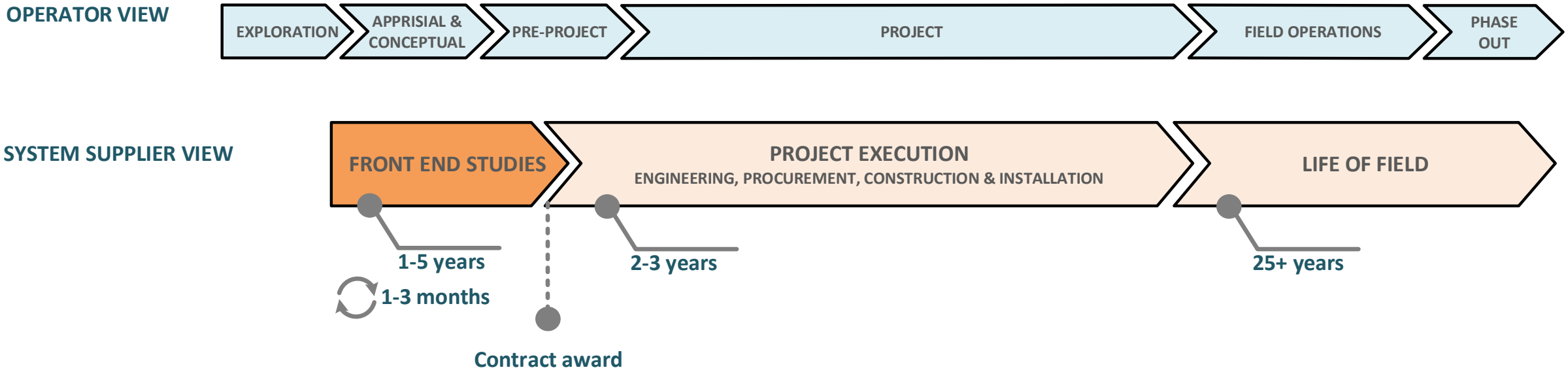
Problem and research approach

Results

– Current situation – Creating the A3AO – Evaluation

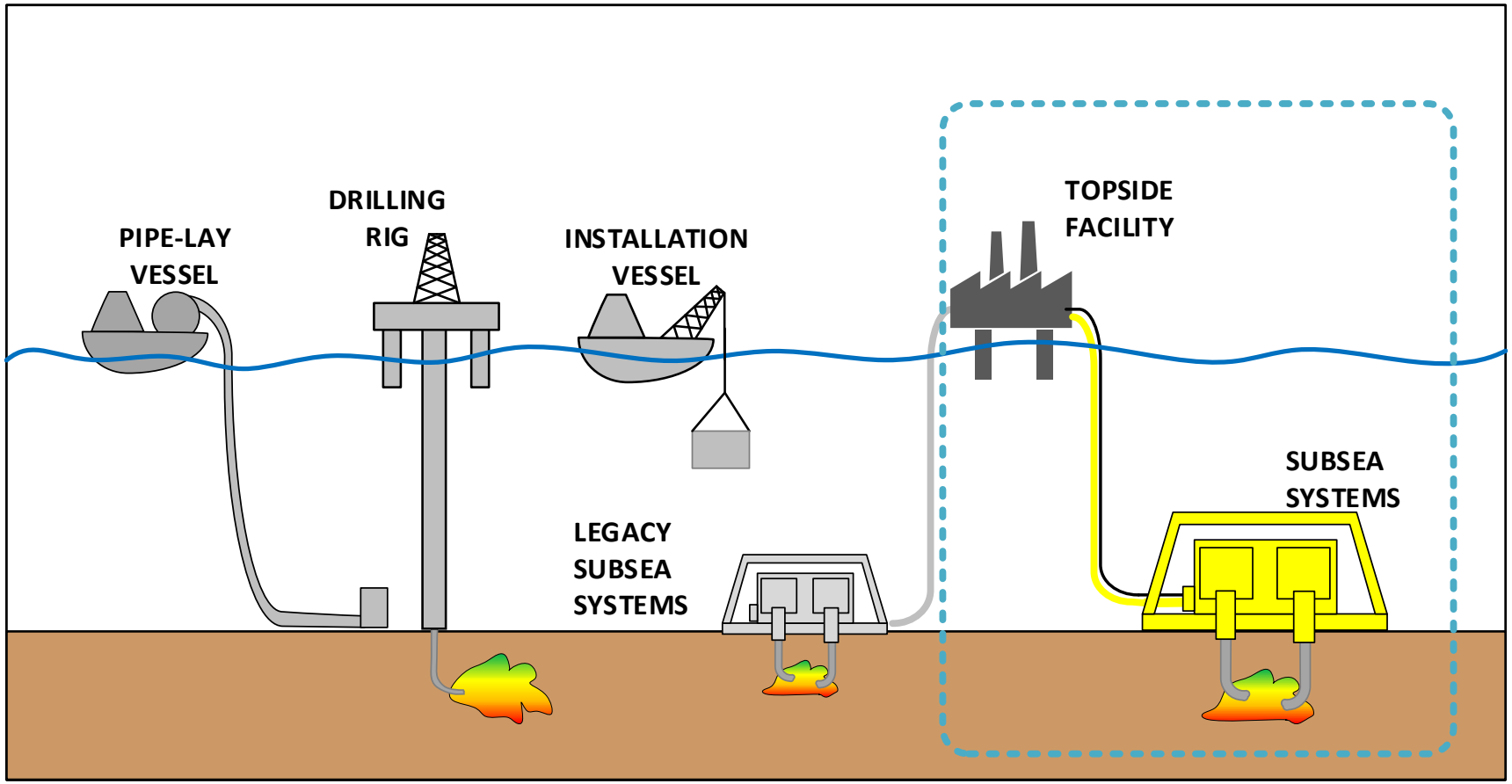
Concluding remarks

The subsea field development study

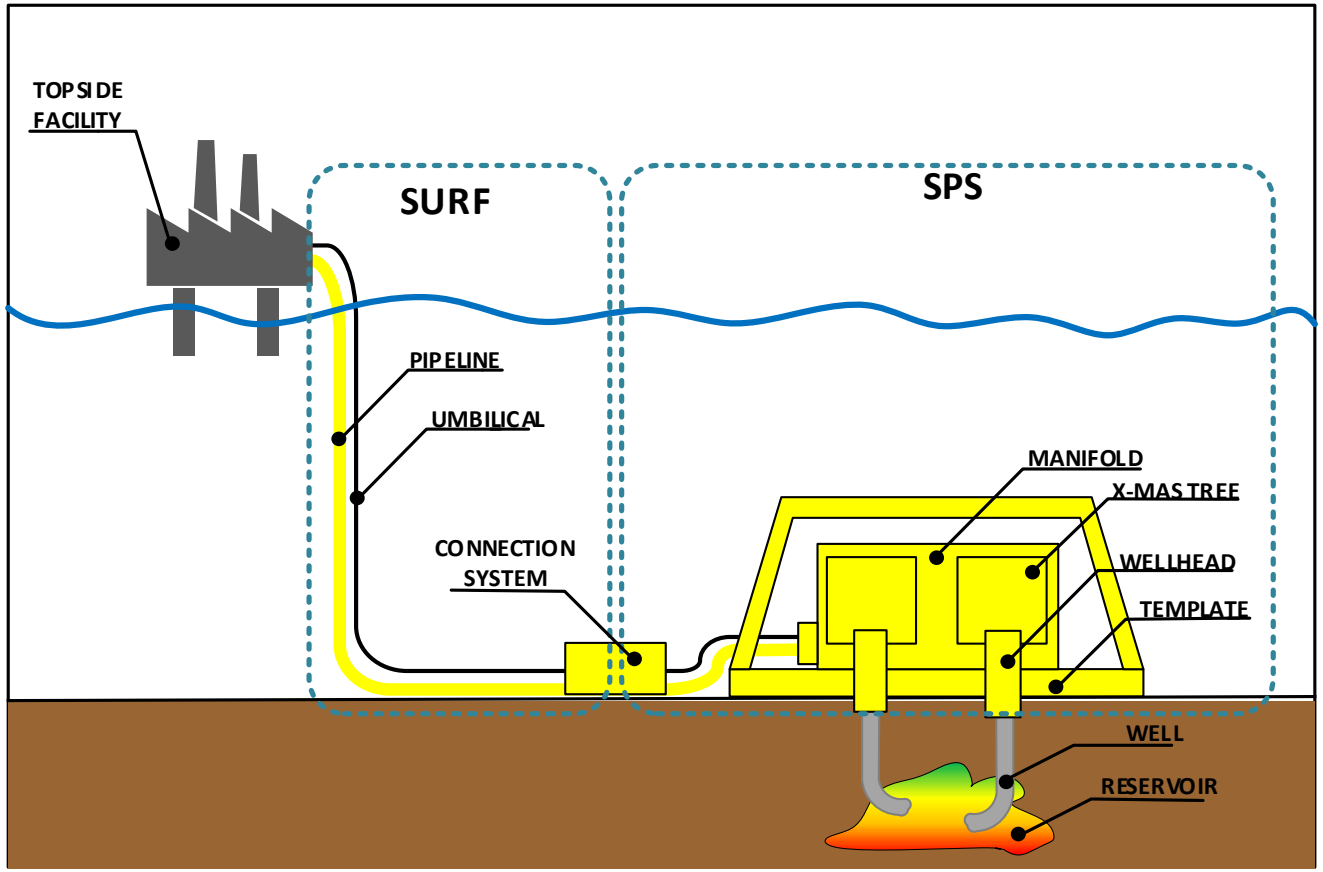


Overall goal: support early-phase decision making

Subsea field development



Subsea system



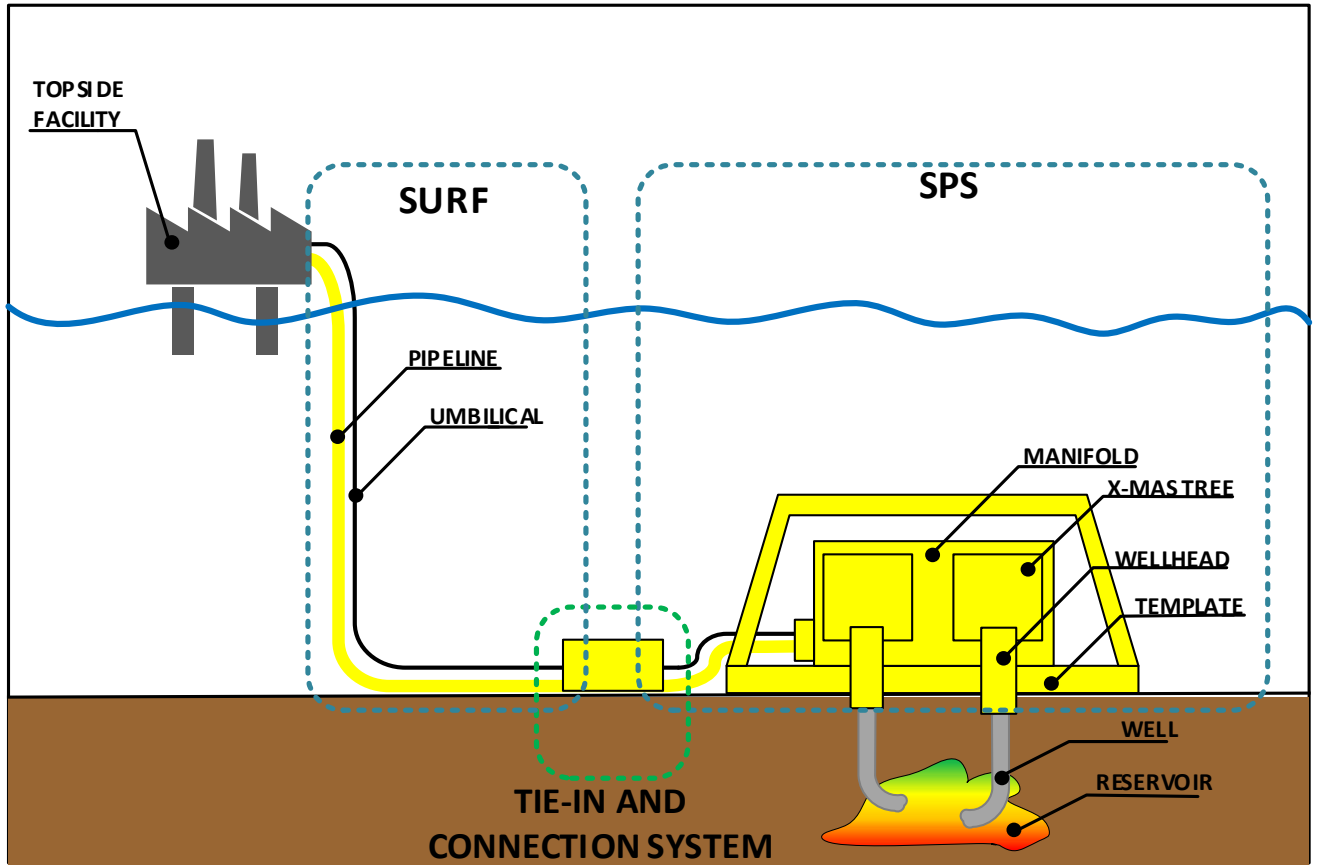
SPS

Subsea Production System

SURF

Subsea umbilicals, risers and flowlines

Subsea system



SPS

Subsea Production System

SURF

Subsea umbilicals, risers and flowlines

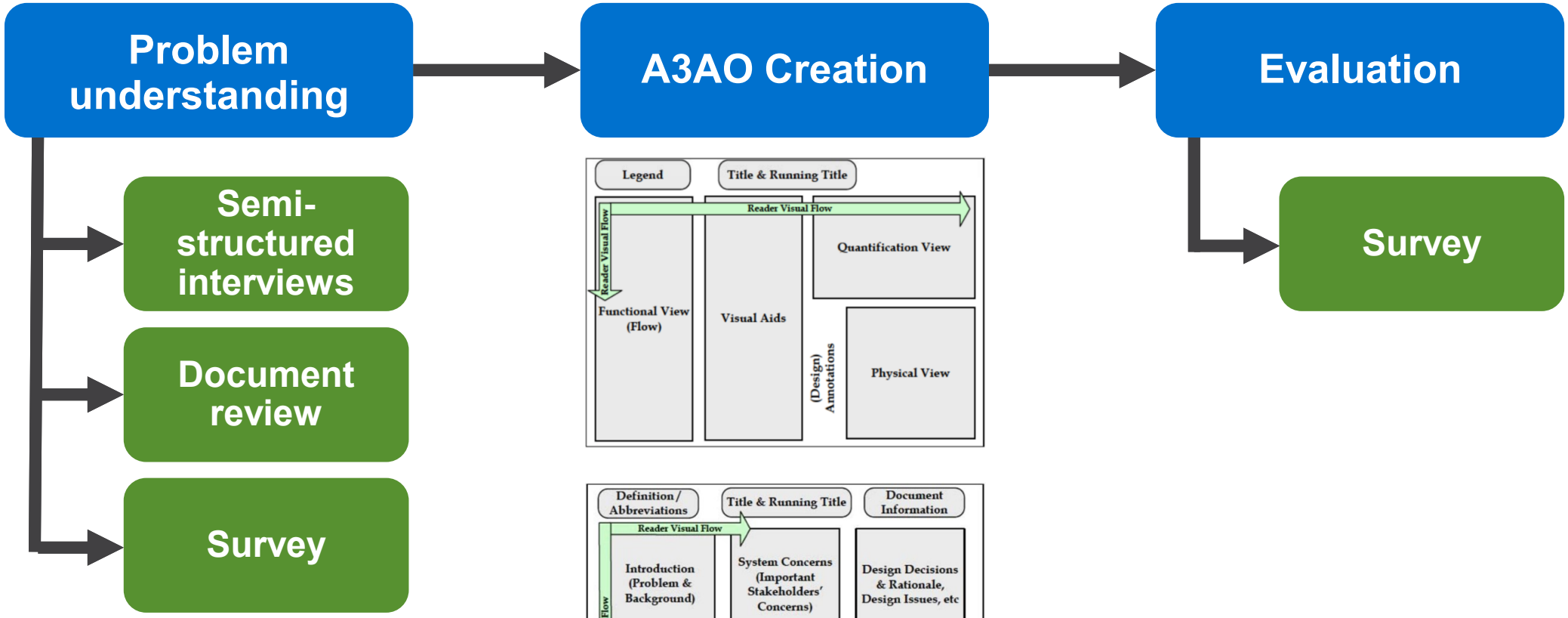
Interface

Tie-in and Connection system

Research problem

- Support **concept evaluation** of the tie-in and connection system considering both SPS and SURF aspects

Research method



Current challenges in the company

"We don't follow a particular approach when evaluating concepts, we basically gather experts around the table and agrees upon a solution."

Field Development Engineer

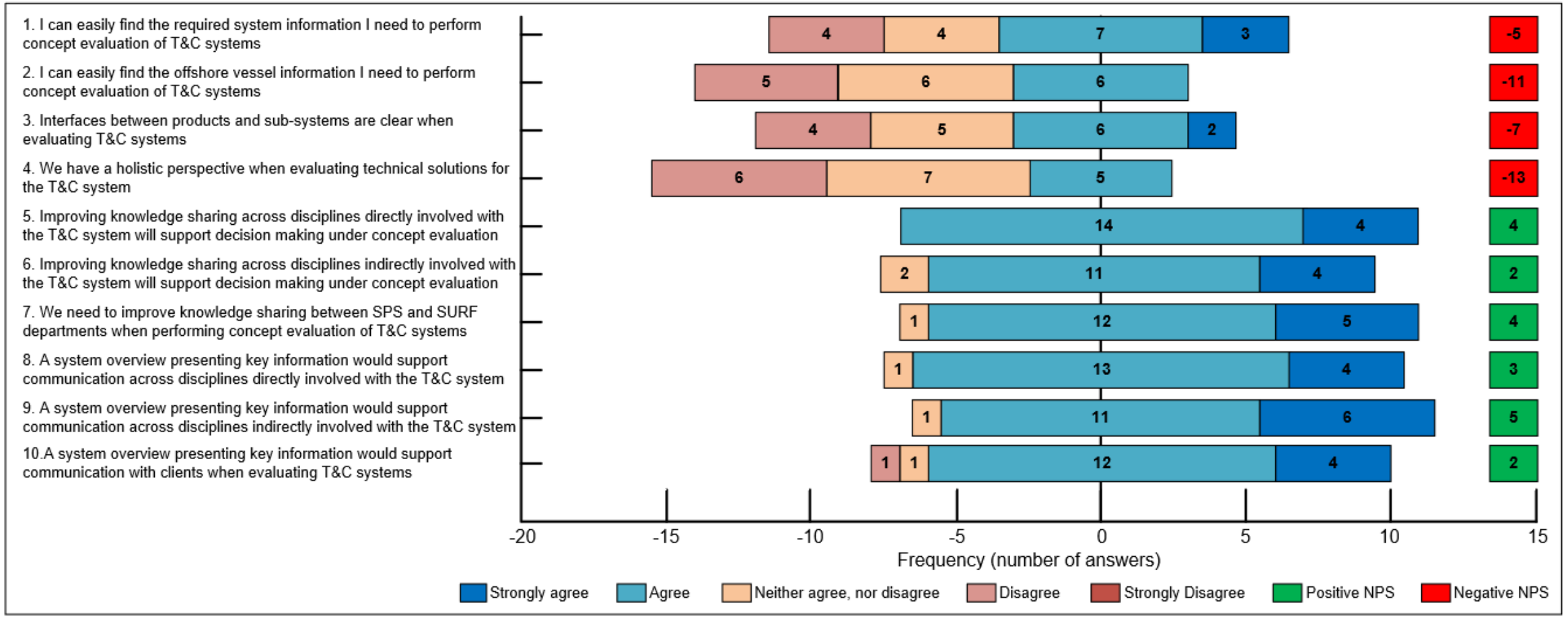
"In my opinion, we lack a mutual understanding about each other's needs and drivers."

Engineer Manager, SURF

"We need to overcome silo-thinking and align processes to optimize our execution."

Chief Engineer

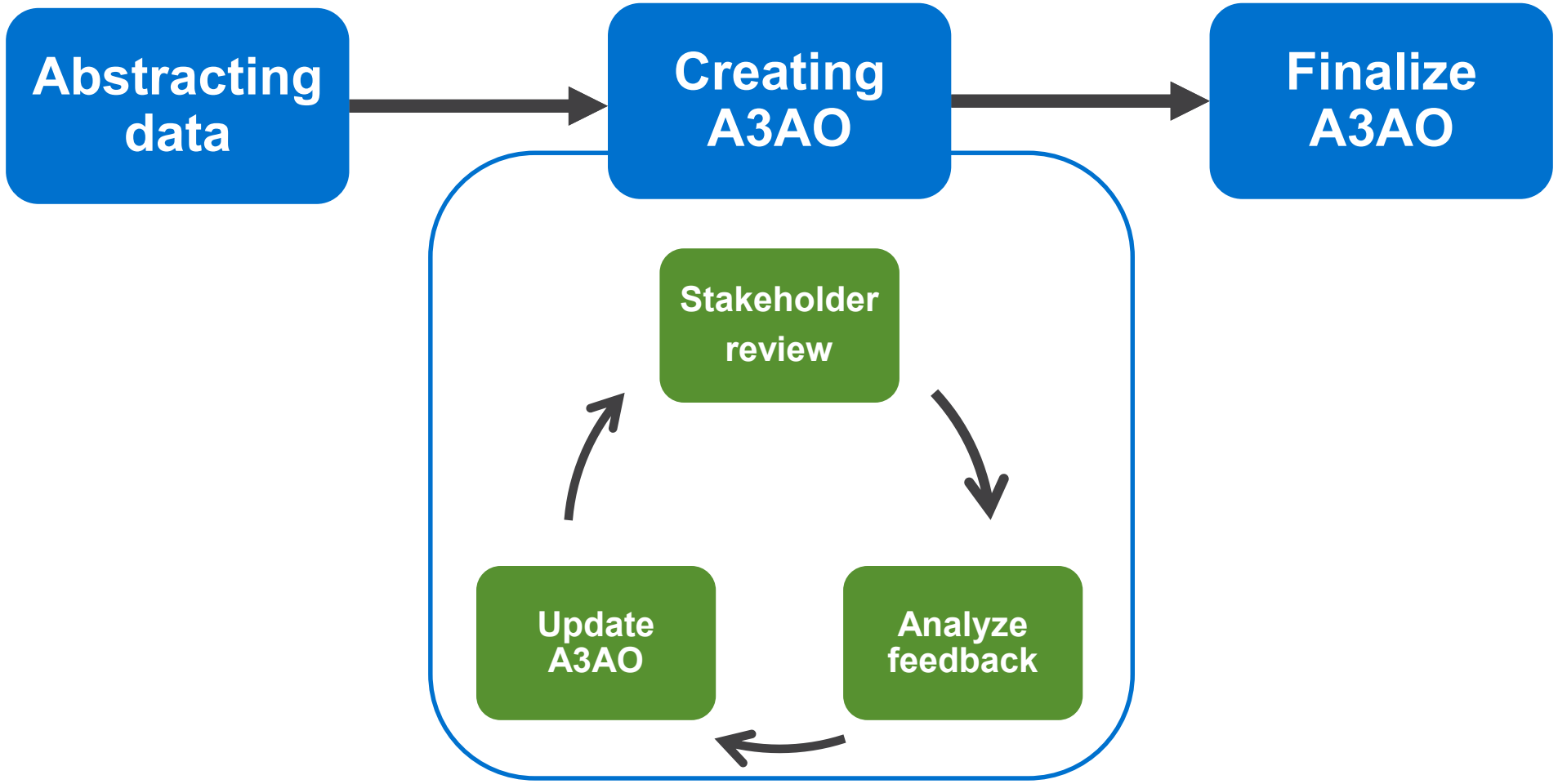
Current challenges in the company



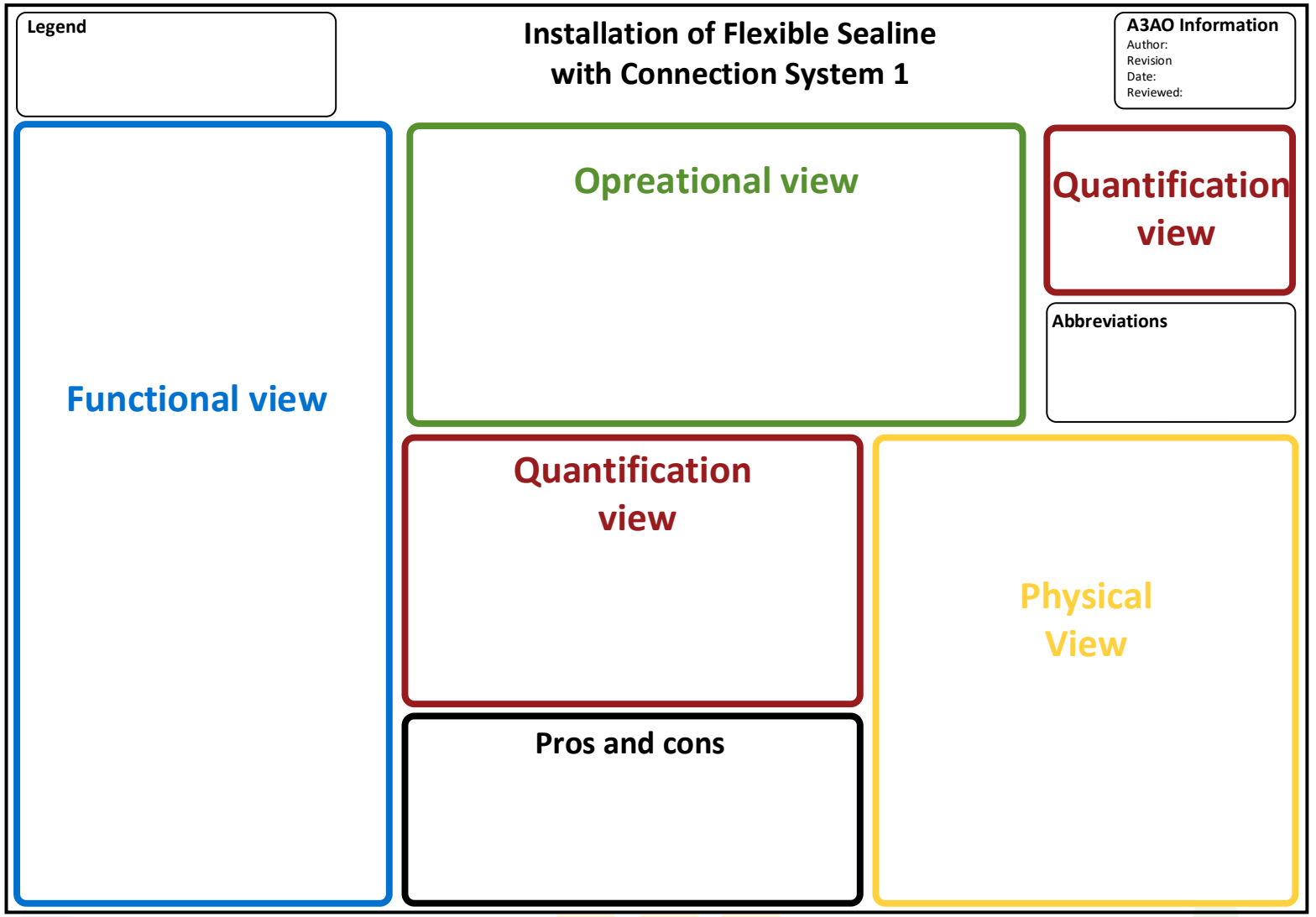
The needs

- **Easy-accessible** format stating key information and main drivers
- System overview to support **knowledge sharing** and **multi-disciplinary communication**
- **Holistic view** – integrate SPS engineering and installation needs from SURF

Creating the A3AO



The A3AO format



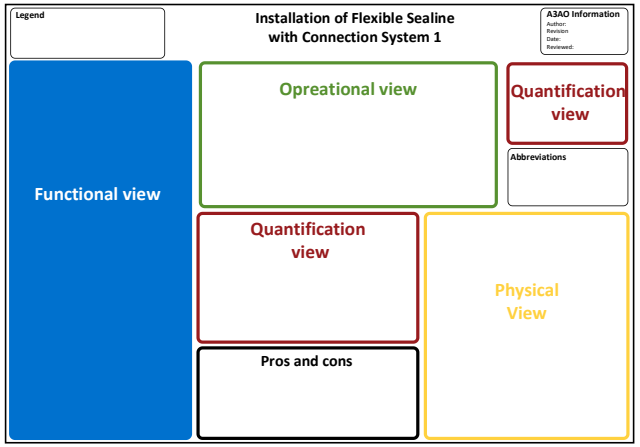
Four views based on literature

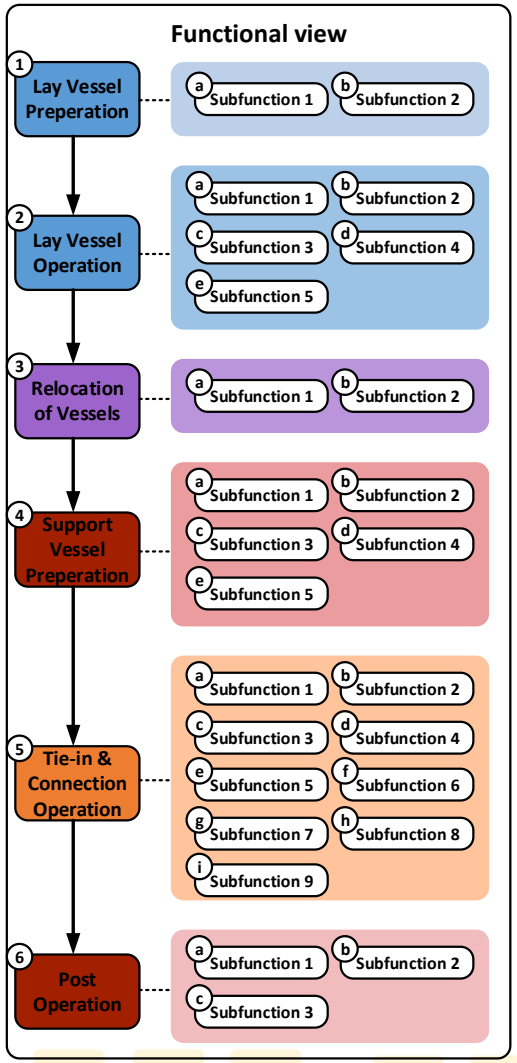
- Functional view
- Operational view
- Physical view
- Quantification view

View added based on need

- Pros and cons

The A3AO

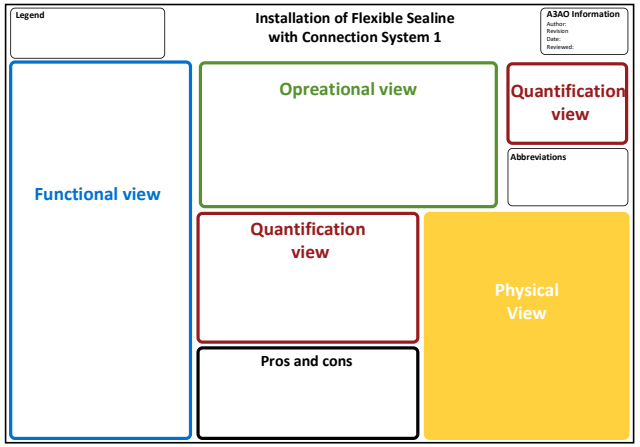


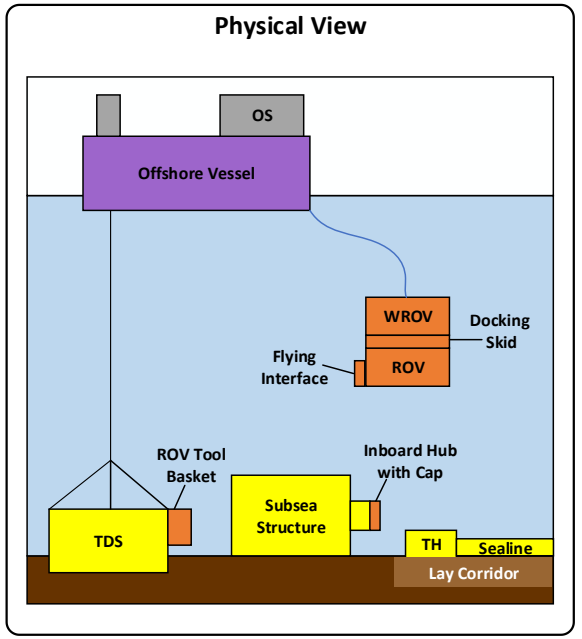


Functional view

- Overview of main activities
- Top level activities
- Break down of sub-activities

The A3AO

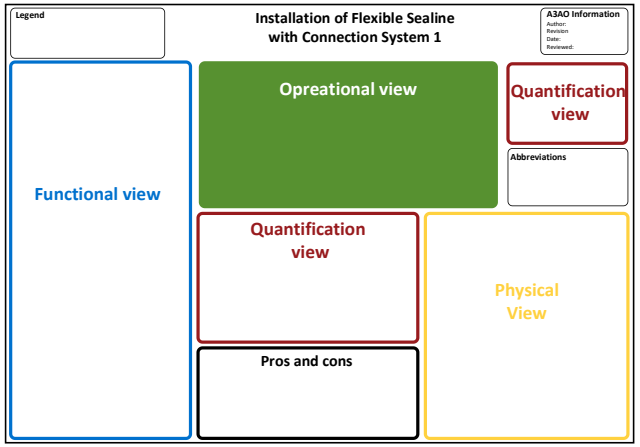


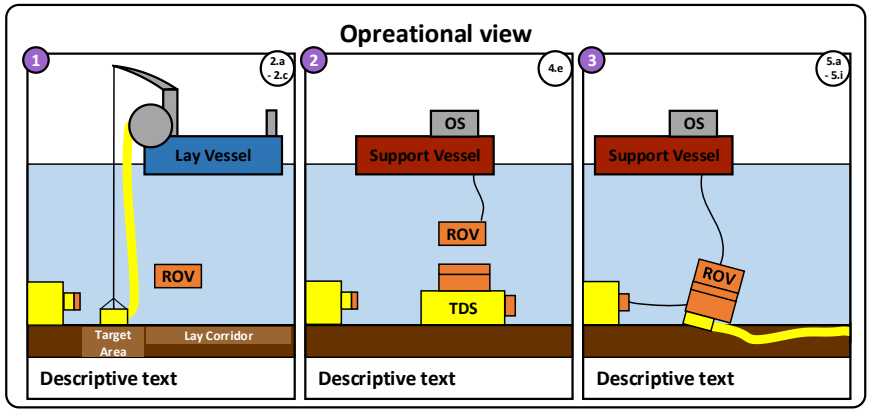


Physical view

- The major building blocks
- Key interfaces

The A3AO

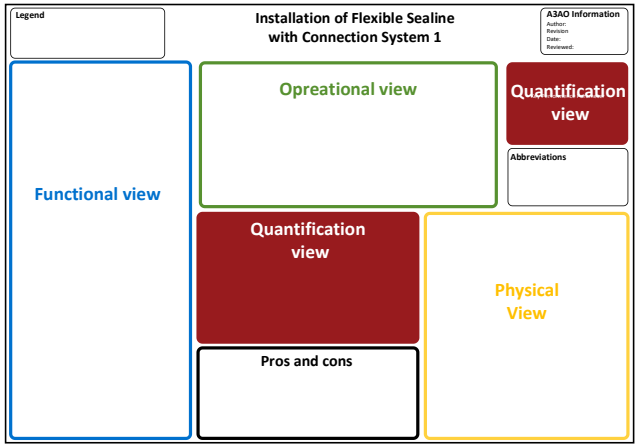




Operational view

- Visualizion of usage scenarios
- Interaction between systems and vessels

The A3AO



Key Performence Parameter

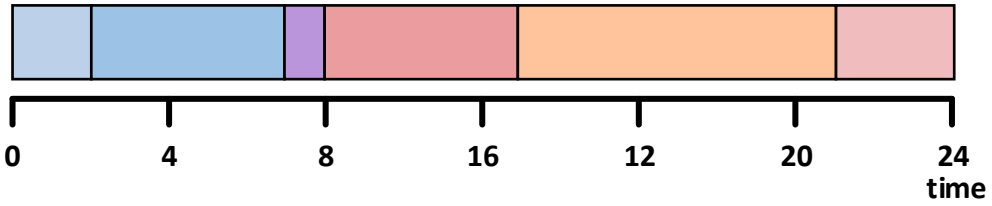
Design Water Depth:
Tempature Range: Design Life:
Design Pressure:
Max Pipe Size:
Tool Weight in water:
Internal Hydraulic Pressure:
Operating Pressure ROV Tools:
Pull-in Force Stroking Force:

Quantification view

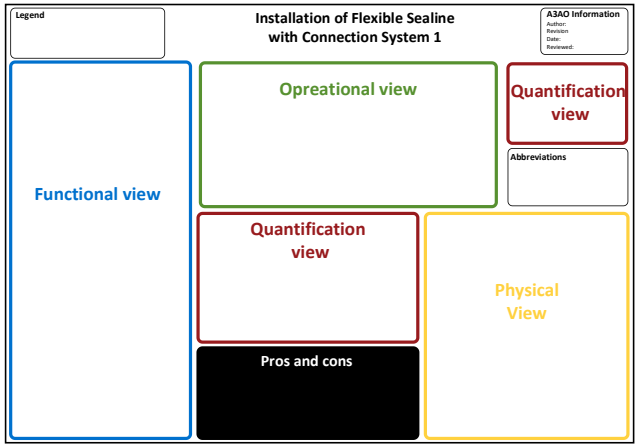
- Key Performance Parameter
- Timeline with duration

Timeline Estimation per Installation

Installation Stage	Duration (time)
Lay Vessel Preparation	2
Lay Vessel Operation	5
Relocation of Vessels	1
Support Vessel Preperation	5
Tie-in & Connection Operation	8
Post Operation	3



The A3AO



Pros and cons

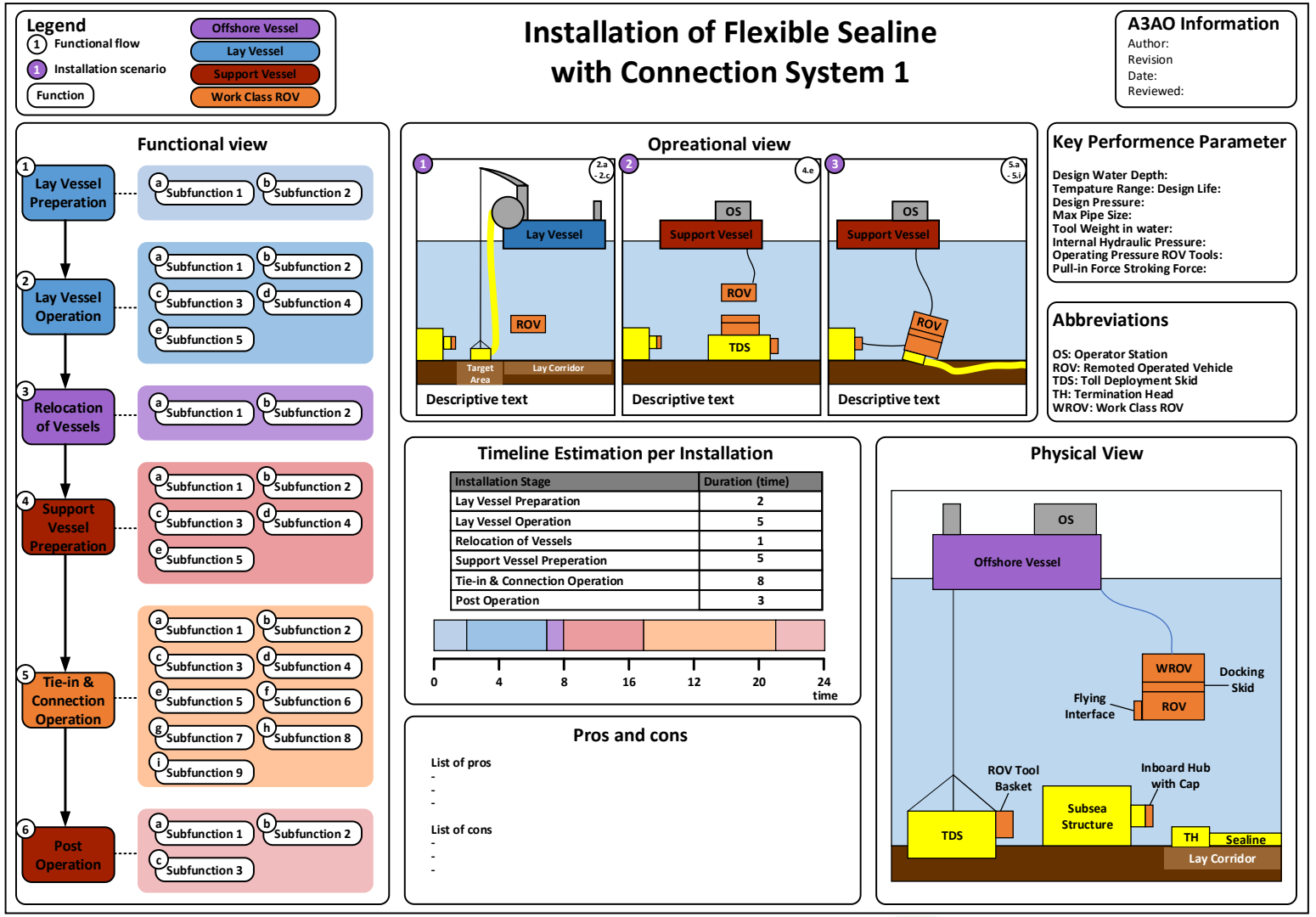
List of pros
-
-
-

List of cons
-
-
-

Pro and cons

- The most important factors affecting the concept evaluation

The A3AO


Legend
Functional flow
Installation scenario
Function
Offshore Vessel
Lay Vessel
Support Vessel
Work Class ROV
Installation of Flexible Sealine with Connection System 1
A3AO Information
Author:
Revision
Date:
Reviewed:
Functional view
1 Lay Vessel Preperation
a Subfunction 1
b Subfunction 2
2 Lay Vessel Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
3 Relocation of Vessels
a Subfunction 1
b Subfunction 2
4 Support Vessel Preperation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
5 Tie-in & Connection Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
f Subfunction 6
g Subfunction 7
h Subfunction 8
i Subfunction 9
6 Post Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
Opreational view
Lay Vessel
ROV
Target Area
Lay Corridor
Descriptive text
OS
Support Vessel
ROV
TDS
Descriptive text
OS
Support Vessel
ROV
Descriptive text
Key Performence Parameter
Design Water Depth:
Tempature Range: Design Life:
Design Pressure:
Max Pipe Size:
Tool Weight in water:
Internal Hydraulic Pressure:
Operating Pressure ROV Tools:
Pull-in Force Stroking Force:
Abbreviations
OS: Operator Station
ROV: Remoted Operated Vehicle
TDS: Toll Deployment Skid
TH: Termination Head
WROV: Work Class ROV
Timeline Estimation per Installation
Installation Stage | Duration (time)
Lay Vessel Preparation | 2
Lay Vessel Operation | 5
Relocation of Vessels | 1
Support Vessel Preperation | 5
Tie-in & Connection Operation | 8
Post Operation | 3
0 4 8 16 12 20 24
time
Pros and cons
List of pros
-
-
-
List of cons
-
-
-
Physical View
OS
Offshore Vessel
WROV
ROV
Docking Skid
Flying Interface
ROV Tool Basket
Inboard Hub with Cap
Subsea Structure
TDS
TH
Sealine
Lay Corridor

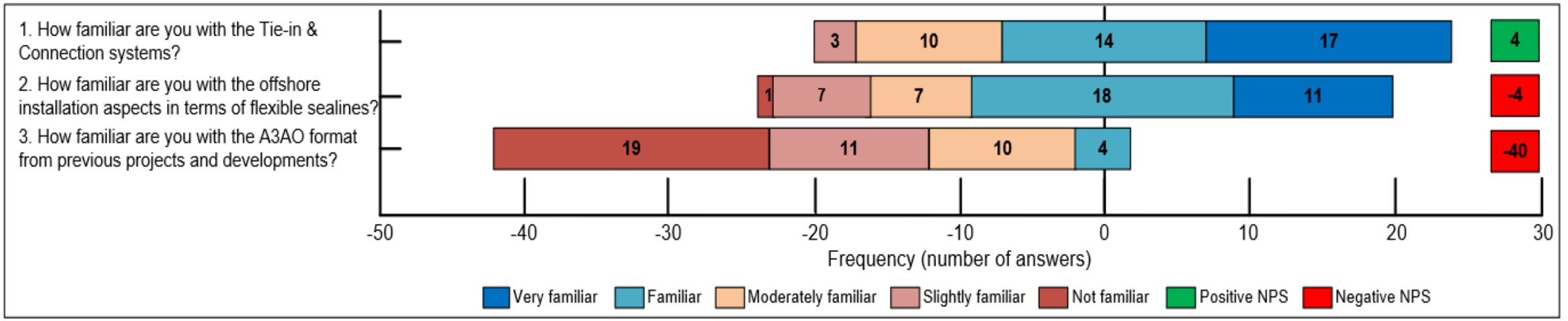
Evaluating the A3AOs

- Connection and SURF
- 12 respondents

- Systems engineers
- 32 respondents

- In total 44 respondents
- Avrage of 19 years experience in company

Evaluating the A3AOs



Evaluating the A3AOs

All respondents

- Positive to use of A3AO as the holistic overview of the system of interest
- Support communication internal and external
- Improve understanding

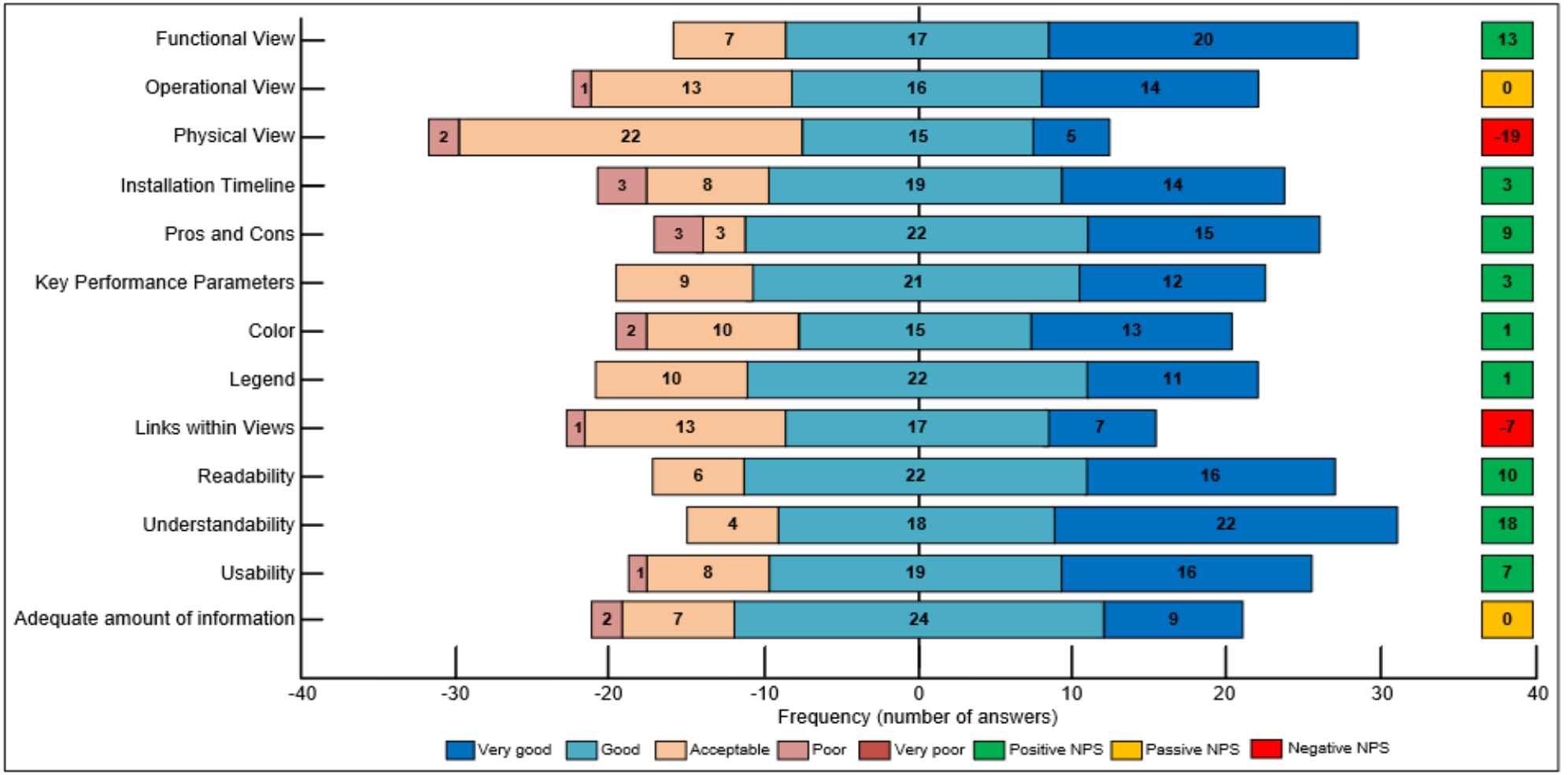
Connection and SURF

- Improve knowledge sharing, promote common understanding
- Support training of new employees
- Less useful for internal discussion

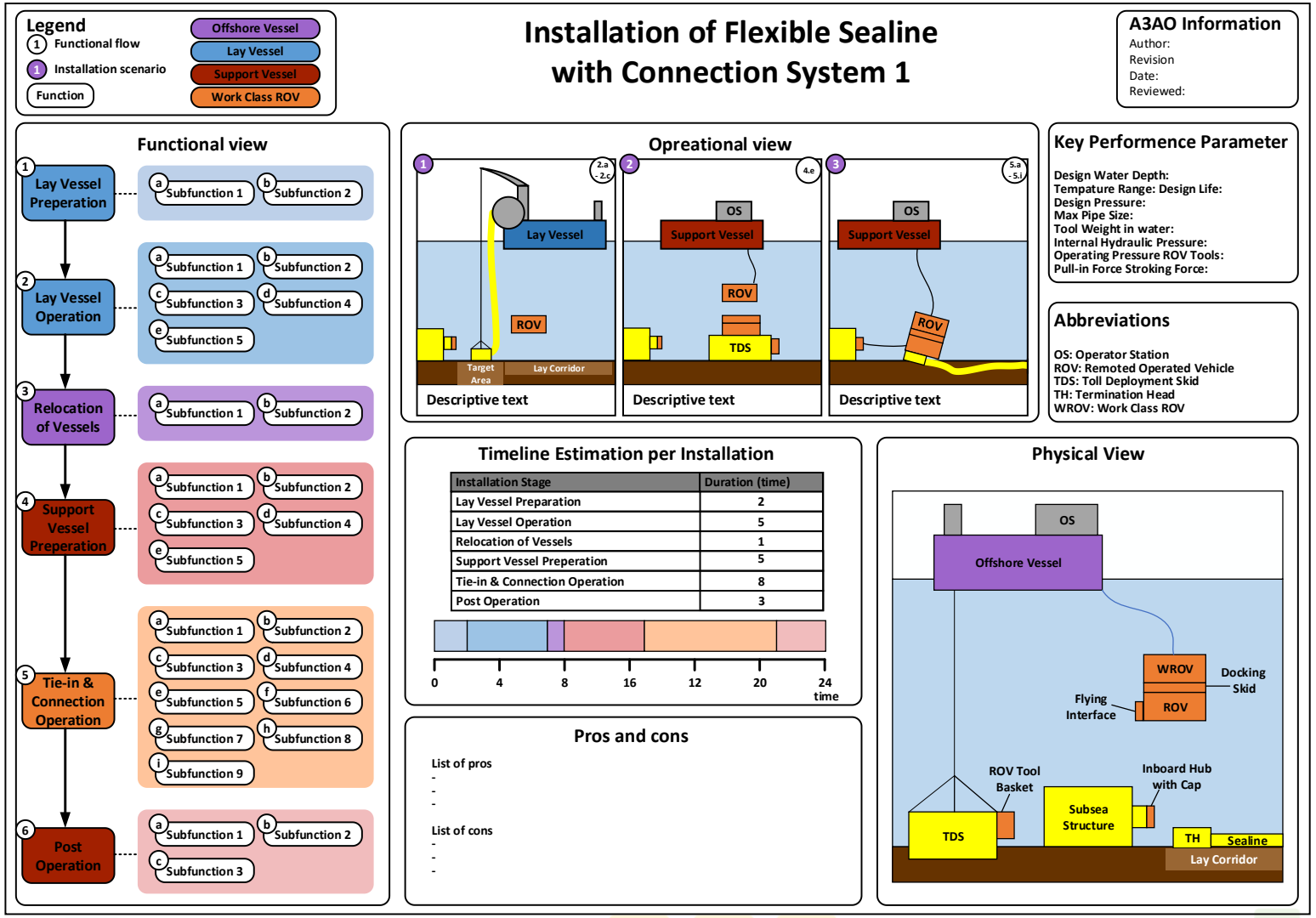
Systems Engineers

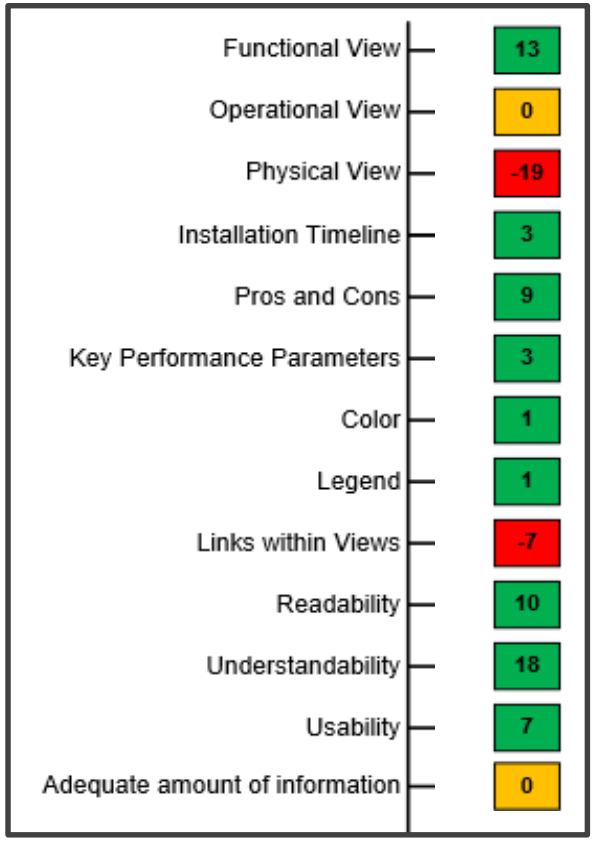
- Capture key aspects and provide rapid key information
- Less supportive than the Tie-In group

Evaluating the A3AOs



The A3AO


Legend
Functional flow
Installation scenario
Function
Offshore Vessel
Lay Vessel
Support Vessel
Work Class ROV
Installation of Flexible Sealine with Connection System 1
A3AO Information
Author:
Revision
Date:
Reviewed:
Functional view
1 Lay Vessel Preperation
a Subfunction 1
b Subfunction 2
2 Lay Vessel Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
3 Relocation of Vessels
a Subfunction 1
b Subfunction 2
4 Support Vessel Preperation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
5 Tie-in & Connection Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
d Subfunction 4
e Subfunction 5
f Subfunction 6
g Subfunction 7
h Subfunction 8
i Subfunction 9
6 Post Operation
a Subfunction 1
b Subfunction 2
c Subfunction 3
Opreational view
Lay Vessel
ROV
Target Area
Lay Corridor
Descriptive text
OS
Support Vessel
ROV
TDS
Descriptive text
OS
Support Vessel
ROV
Descriptive text
Key Performence Parameter
Design Water Depth:
Tempature Range: Design Life:
Design Pressure:
Max Pipe Size:
Tool Weight in water:
Internal Hydraulic Pressure:
Operating Pressure ROV Tools:
Pull-in Force Stroking Force:
Abbreviations
OS: Operator Station
ROV: Remoted Operated Vehicle
TDS: Toll Deployment Skid
TH: Termination Head
WROV: Work Class ROV
Timeline Estimation per Installation
Installation Stage | Duration (time)
Lay Vessel Preparation | 2
Lay Vessel Operation | 5
Relocation of Vessels | 1
Support Vessel Preperation | 5
Tie-in & Connection Operation | 8
Post Operation | 3
0 4 8 16 12 20 24
time
Physical View
OS
Offshore Vessel
WROV
ROV
Docking Skid
Flying Interface
ROV Tool Basket
Inboard Hub with Cap
Subsea Structure
TDS
TH
Sealine
Lay Corridor
Pros and cons
List of pros
-
-
-
List of cons
-
-
-


Functional View 13
Operational View 0
Physical View -19
Installation Timeline 3
Pros and Cons 9
Key Performance Parameters 3
Color 1
Legend 1
Links within Views -7
Readability 10
Understandability 18
Usability 7
Adequate amount of information 0

Conclusion and further work

Needs

- Access to key information
- Improve knowledge sharing and communication across disciplines
- Improve holistic view

Benefits of the A3AO

- Communicating the system information for early phase
- Rapid manner to access key information
- Prefer visual above text-based information

Further work

- Application in concept evaluation
- Develop A3AO for lower level and other aspects

Thank you for your attention