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Managing Knowledge Transfer in Innovative Complex Systems Development: Case Study of Renewable Energy Project in the Oil and Gas Industry

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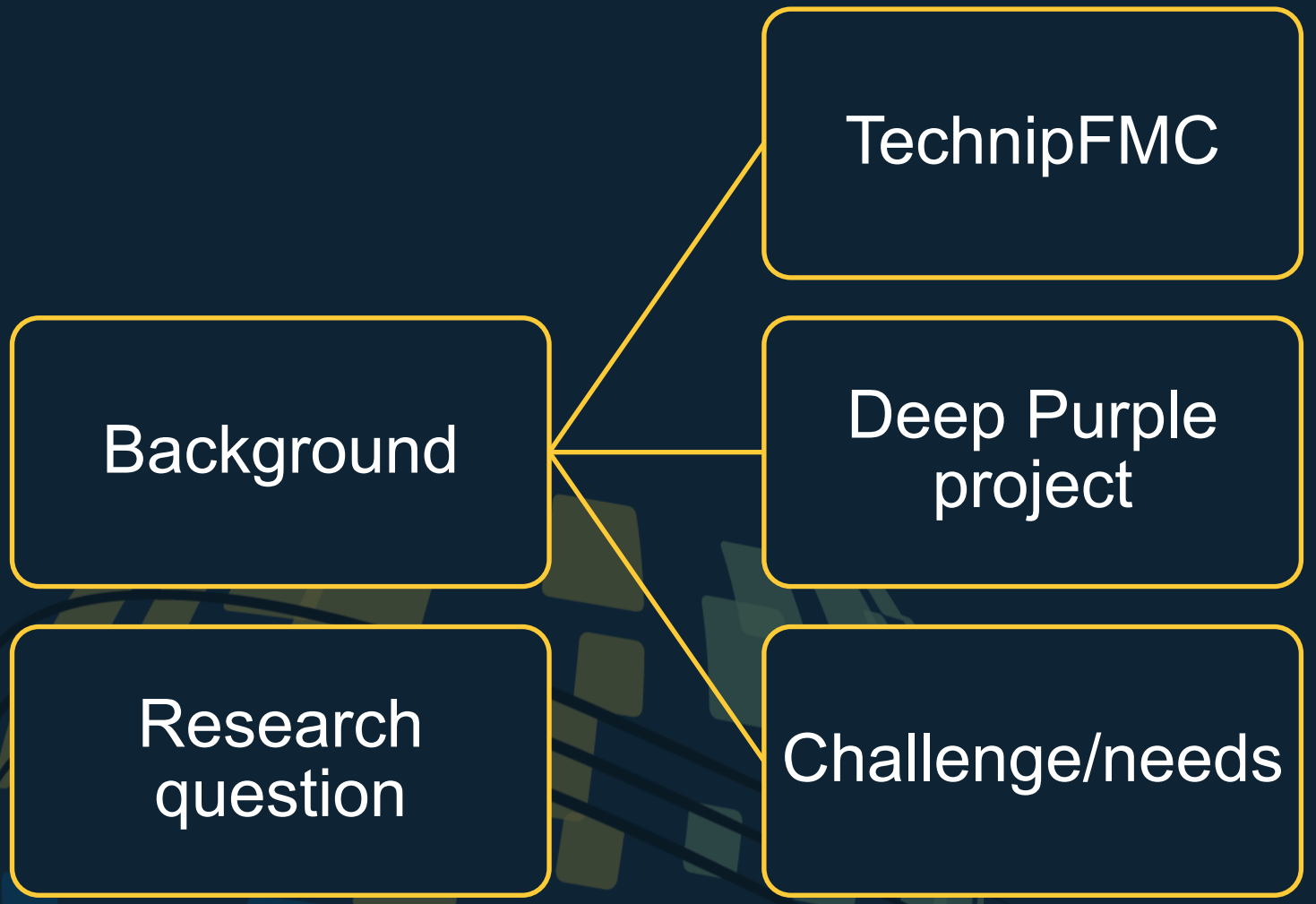
Agenda

1. Introduction
2. Literature Review
3. Conceptual Solution
4. Research Methodology
5. Case Study Findings
6. Results of Verification and Validation
7. Discussion and Conclusion

Introduction

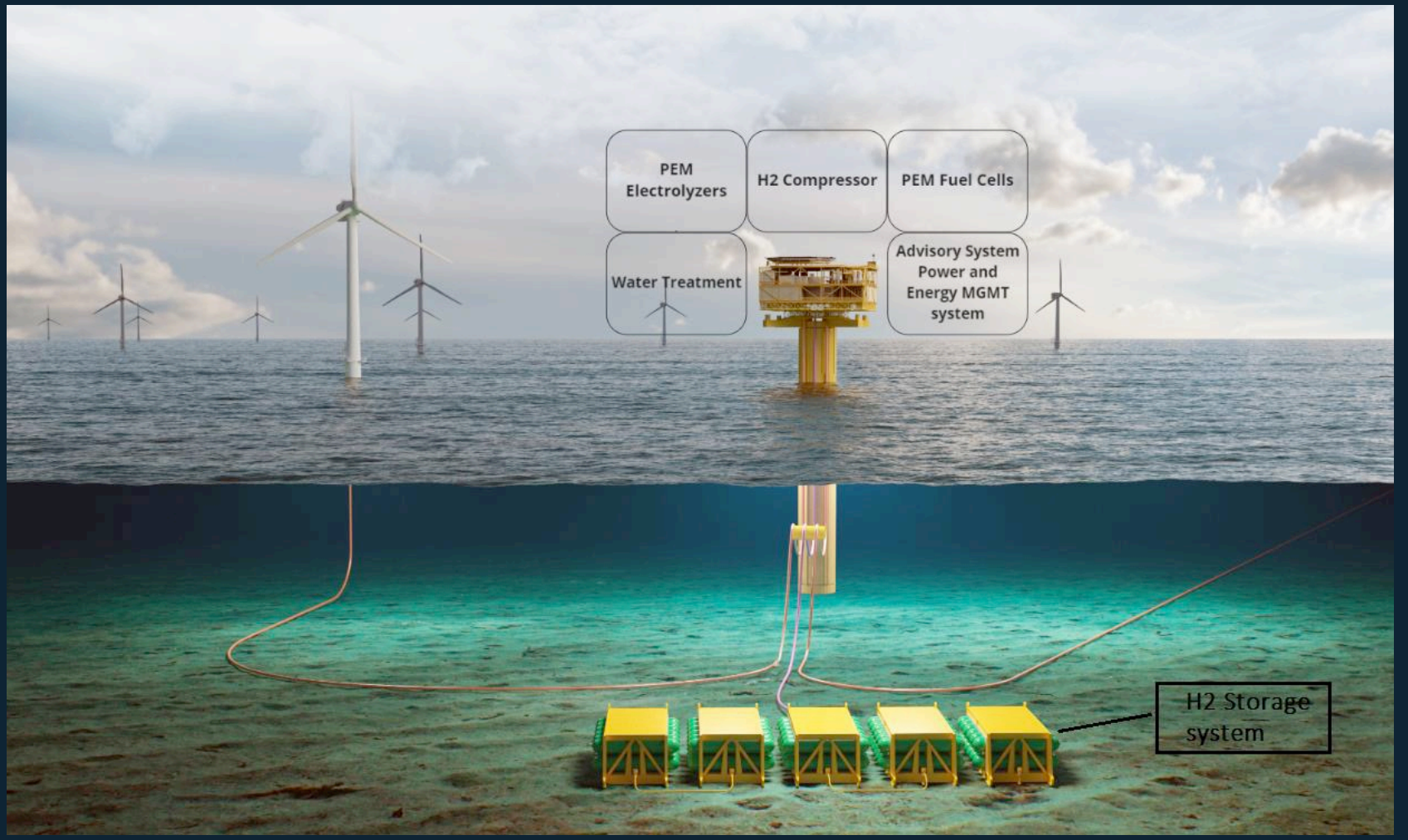


TechnipFMC

a leading technology provider to the traditional and new energies industry, delivering fully integrated projects, products, and services

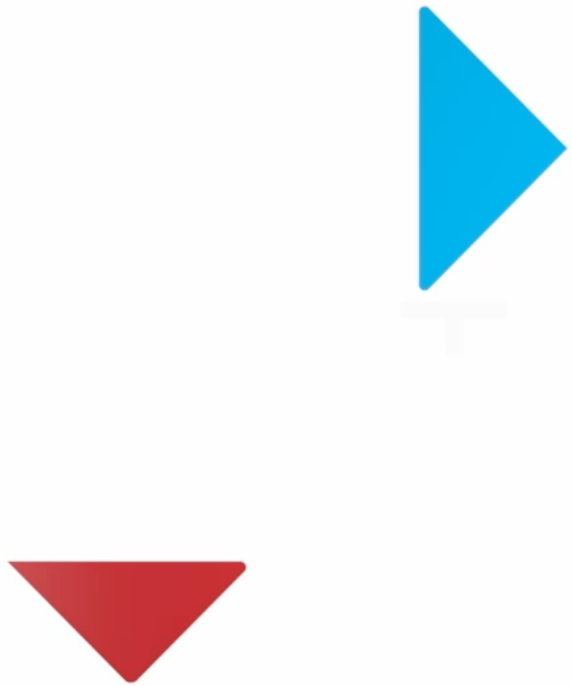
specializes in subsea oil and gas engineering, installation, maintenance service, etc.

new energy project: Deep Purple project

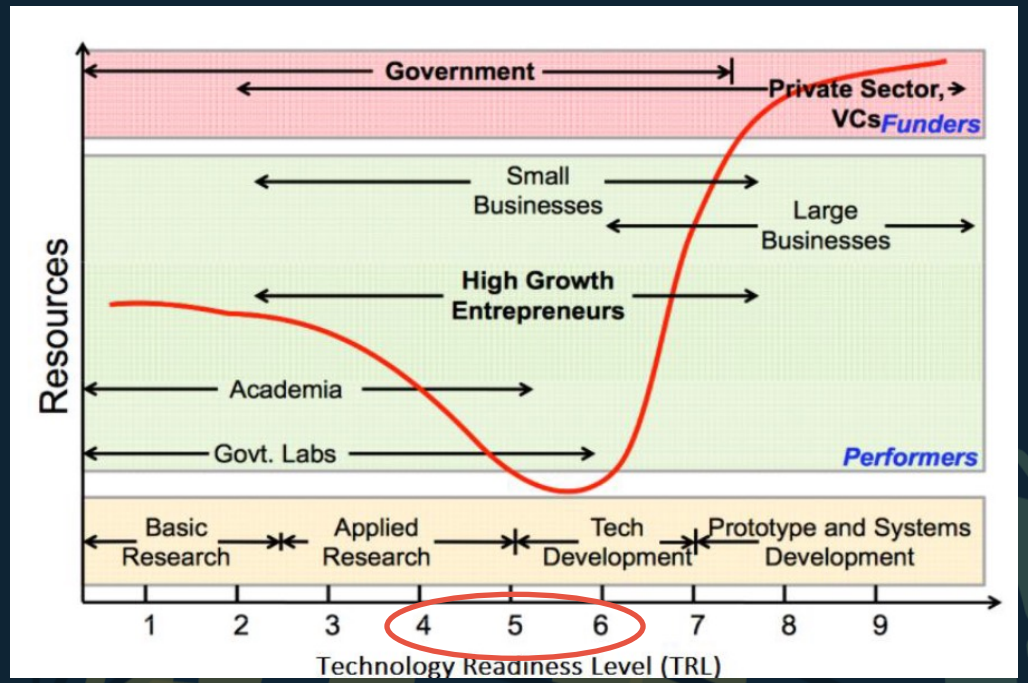


Deep Purple Project

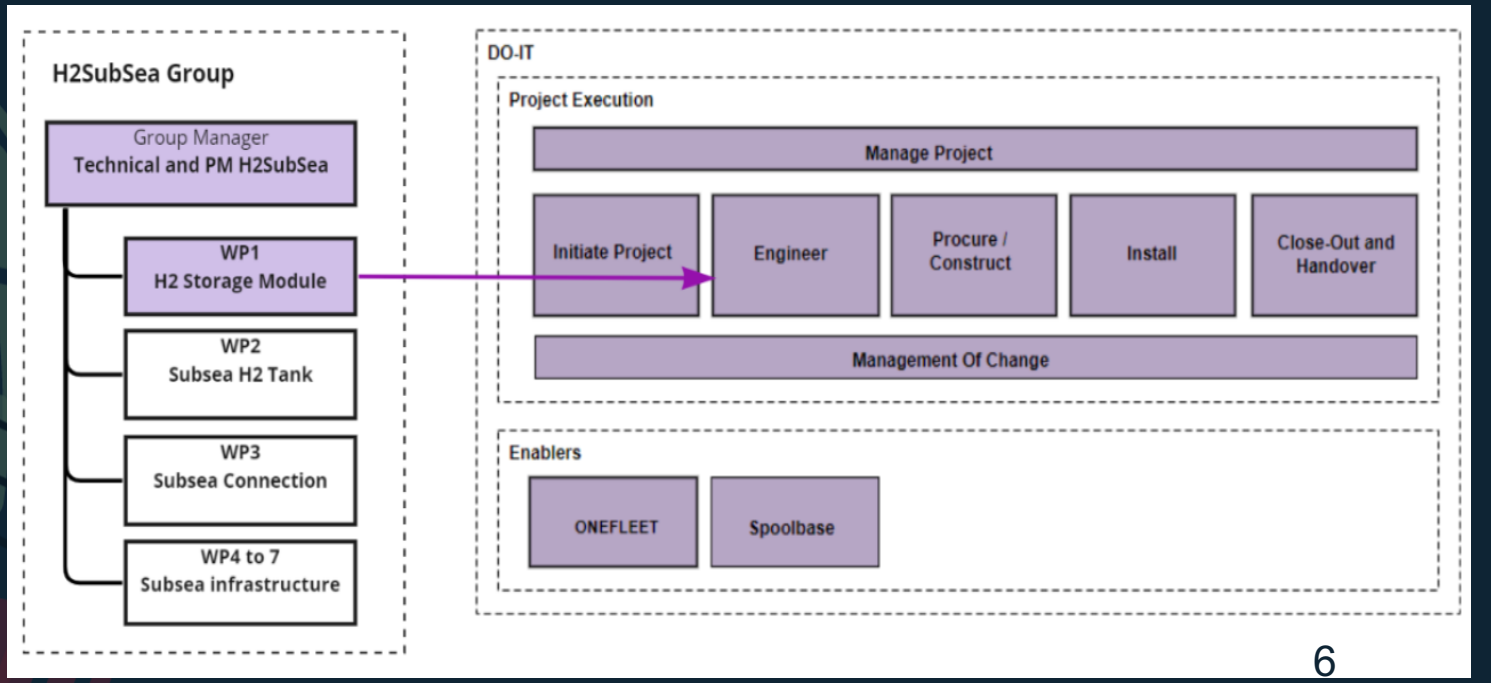
- TechnipFMC is mainly responsible for the subsea scope - Hydrogen Storage system.
- System function introduction video



Challenges/needs



- **Valley of Death, where ideas die**
- **Knowledge transfer - new stakeholders joining after TRL6**



Research Question

How to use A3 Architectural Overviews to facilitate effective knowledge transfer of the technological know-how in the innovative complex systems project?

Literature review

Systems Engineering (SE)	-SE methodology -Stakeholder involvement
Systems Architecture (SA)	-High-level structure of system -Decomposition
A3 Architectural Overviews (A3AOs)	-SA tool for effective communication of architecture knowledge
Application of A3AOs	- Knowledge transfer - New context

Conceptual Solution

Title

Legend

Full scope view of Project

Information/Documents (table)

What (information/document)	Where	Who	Status

Important information

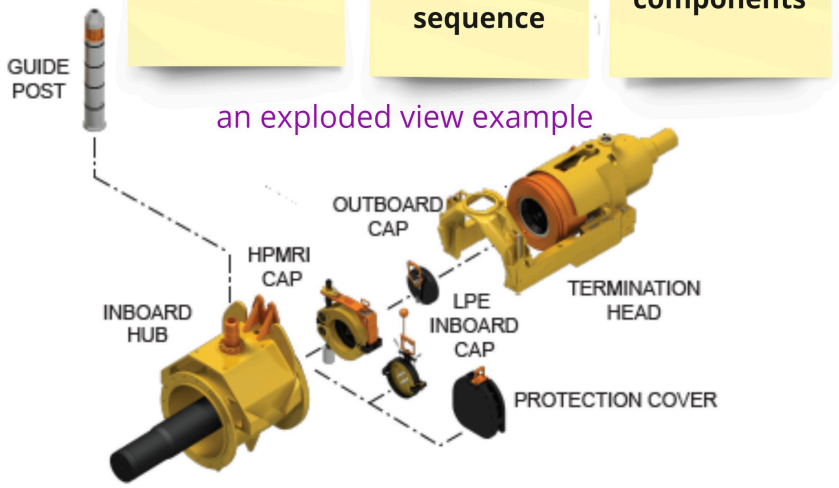
Physical decomposition view

Components and Interfaces

components assembly sequence

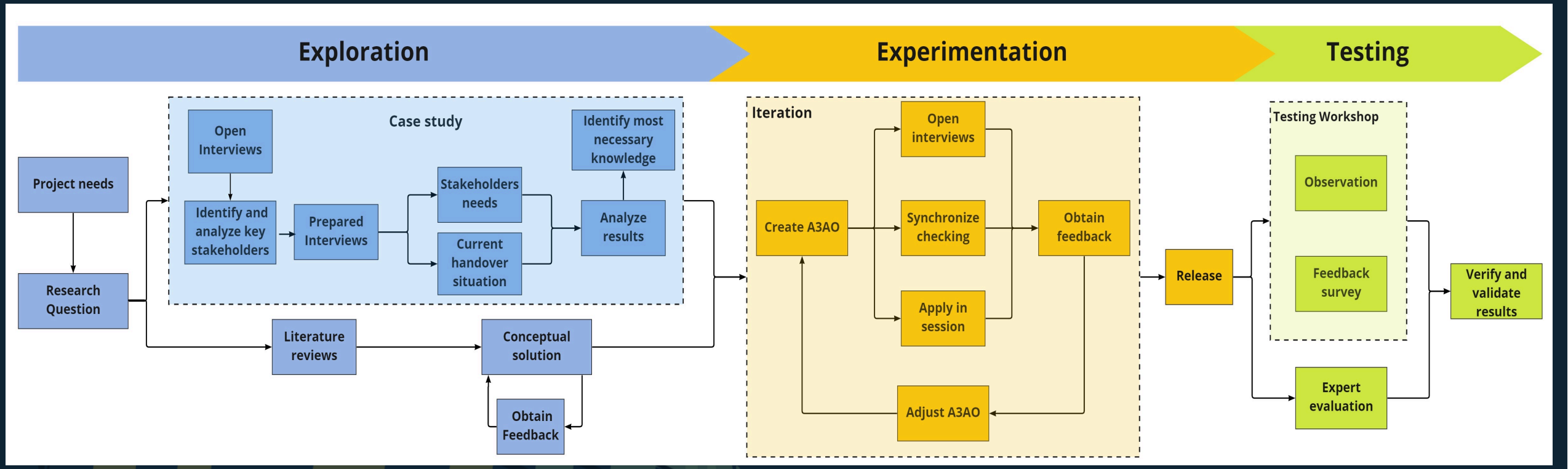
TRL status on critical components

an exploded view example



Research Methodology

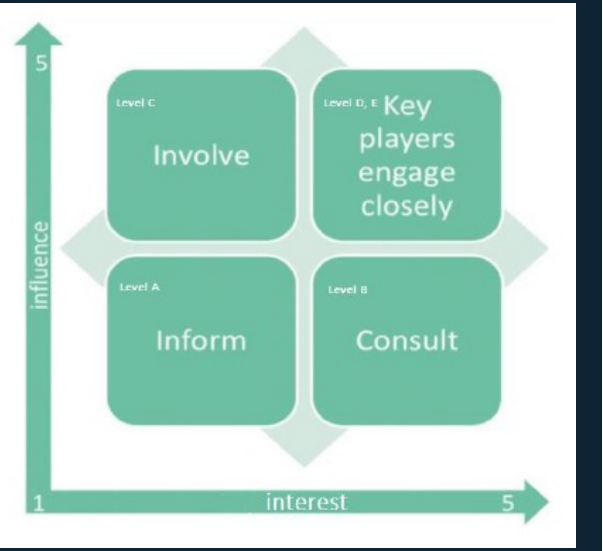
Research Design

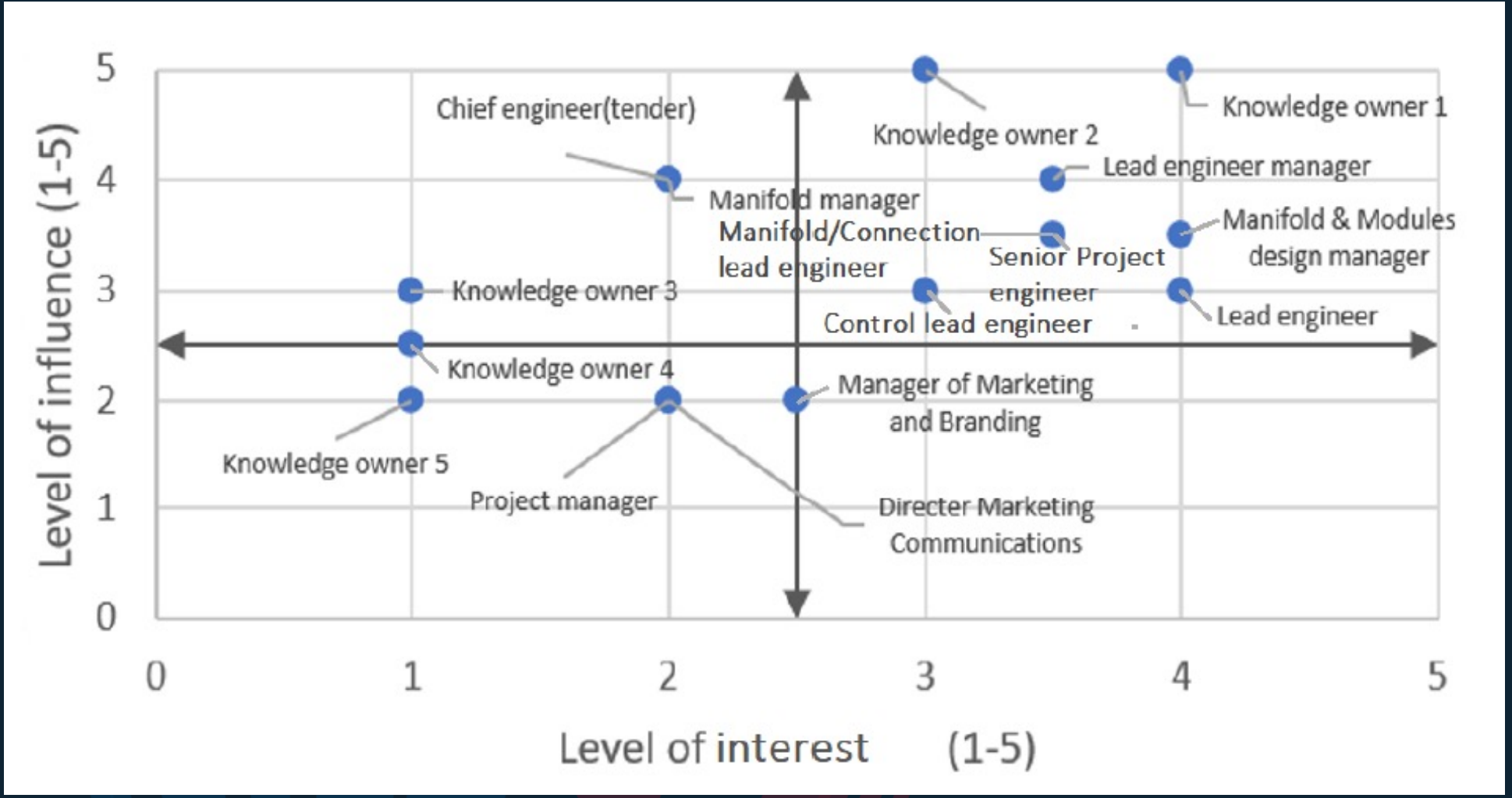


Case Study Findings

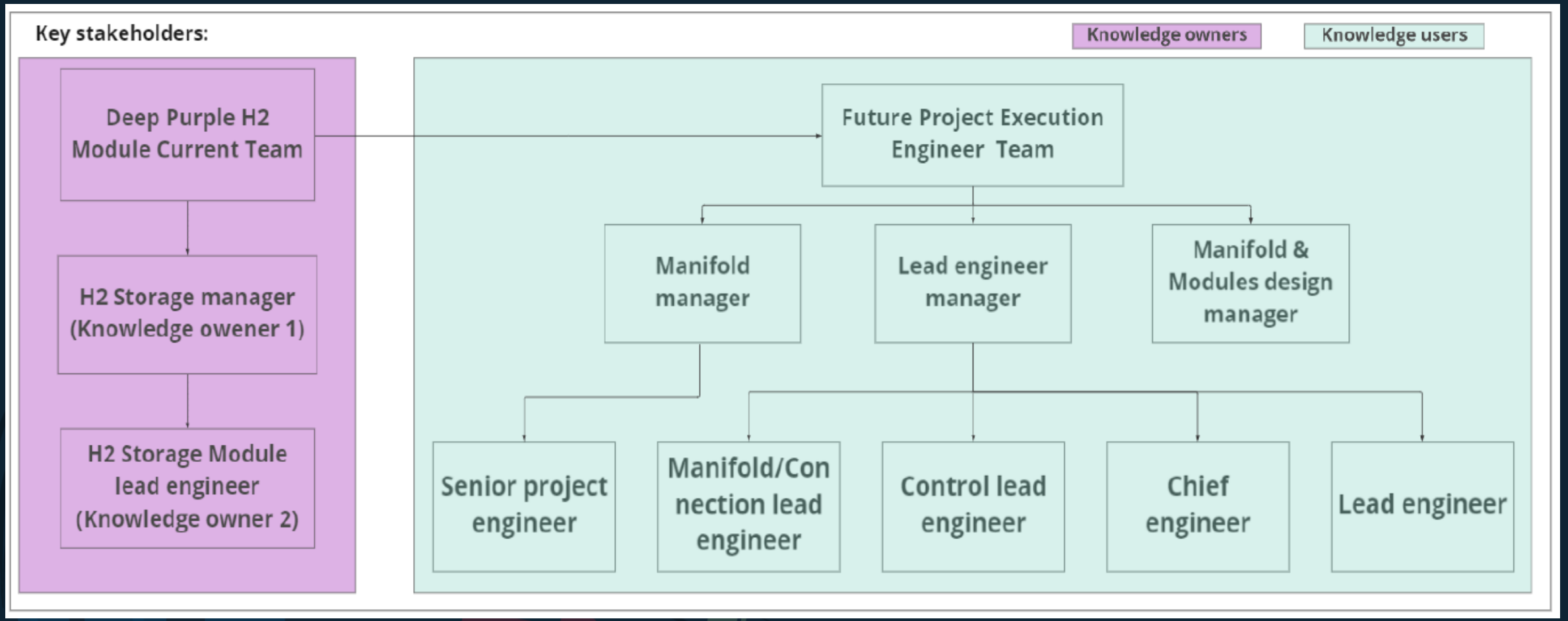
- Key stakeholders
- Key stakeholders' needs
- Current situation of deep purple projects
- Current situation from oil and gas projects
- Optimized solution

Key Stakeholders



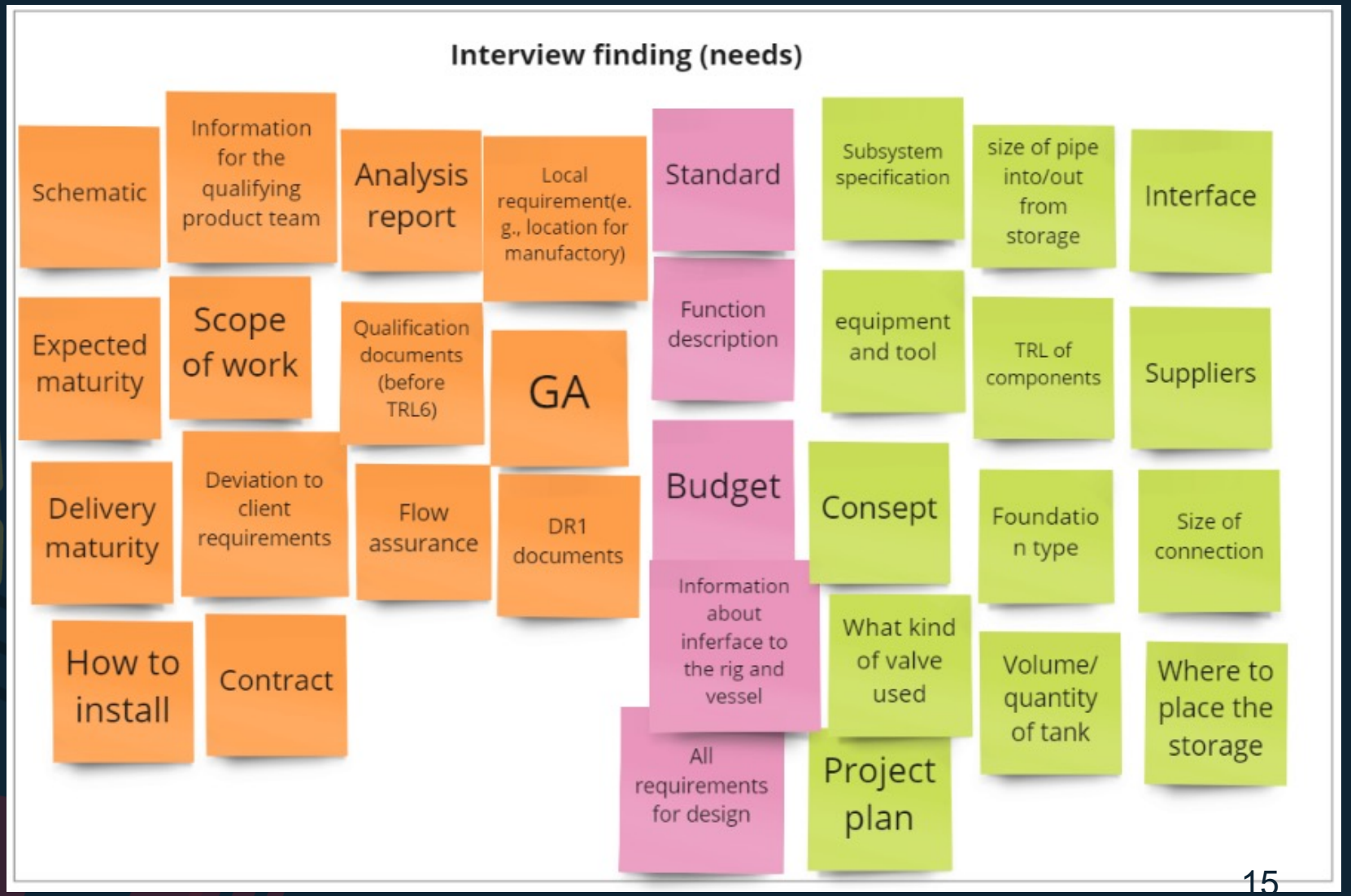


Key Stakeholders



Key Stakeholders' Needs

- What knowledge in need for knowledge transfer and after TRL 6



Key Stakeholders' Needs

Information/knowledge	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8
Consept					x			
Scope of work			x					
Project plan	x	x						
GA					x	x		
Schematic	x	x				x	x	
TRL of components		x	x		x	x	x	
All requirements for design	x	x	x	x	x			x
Subsystem specification	x	x			x	x		
Function description	x							
Analysis report						x		
Qualification documents						x		
Interfaces	x	x			x			x
Between storage and other systems	x				x			x
Between subsystems(components)	x				x			x
Interfaces with rig and Vessel	x	x						x
Suppliers		x						
Equipment and tool		x						
Standard					x			x
Location(to place the storage)					x			
Local requirements (e.g. factory choosen)					x			
How to install			x		x			
Deviation to client requirements			x					
Contract			x		x			
Budget								
Information for the qualifying product team		x						

The Current Situation of the Deep Purple Project

Knowledge is stored in the core knowledge owners

Low efficiency to get info./knowledge for new stakeholders

Under TRL 4-6

Consept	Proof of Consept		Prototyping 1		Prototyping 2		Field Qualified	
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL9
Basic principles obwerved and reported	Technology concept and or application formulated	Experimental proof of concept	Technology validation in lab	Tech valid in relevant environment	Demonstration in relevant environment	Denmonstration to operational environment	Actual system completed and qualified	Successful mission operation

The Current Situation of Oil and Gas Projects

Current handover meeting

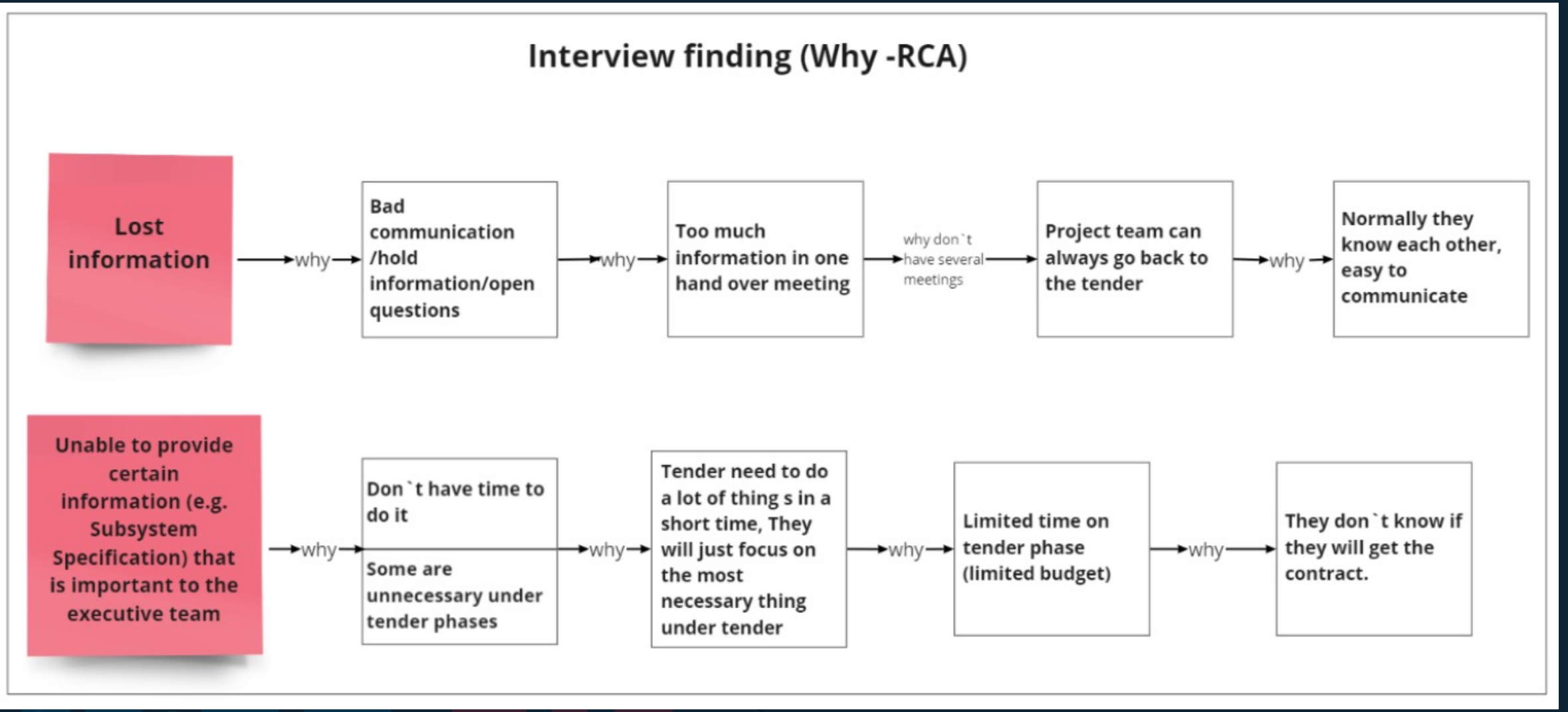
Documents are stored in different places

Some information is not ready

Lost information under the handover meeting

Tenders forgot what they have been discussed during the handover meeting

Root Cause Analysis -5 Whys



Optimized Solution

- Part 1: Information/documents list
- Part 2: Deep Purple technology
- Part 3: Interface between subsystems/components of the H2 storage module

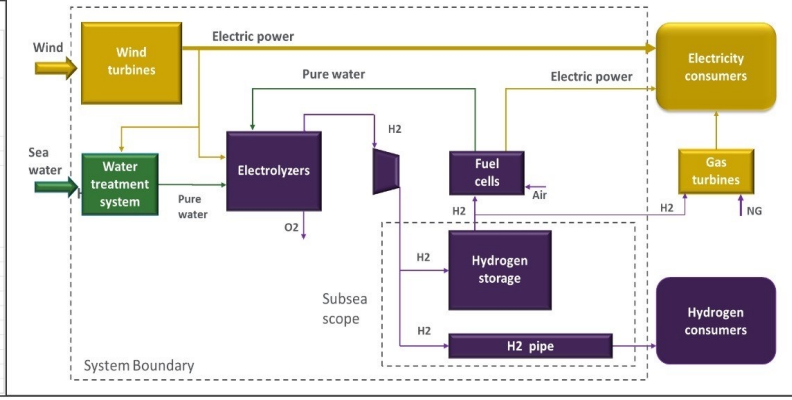
Handover information A3AOs

A3AOs creater: Edith Yayun Chen
Reviewer: Svein Kjenner, Kamrul Hansen
Project: Deep Purple

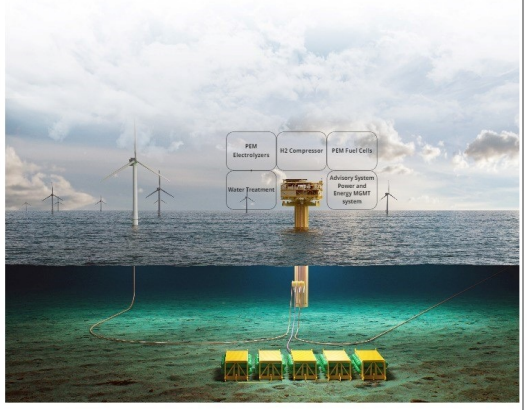
1. Information/documents

Doc No.	Information/Documents	Store place (click the blue text to link)	Owners	Experts	Statues
N/A	Deep Purple H2 Concept Report (TRL of components, Subsystem specification, interfaces, installation, Foundation)	Teams		Svein Kjenner, Kamrul Hansen, Ben Woodward, Steven Manquin, Leiv Egelund	Finished
DU600469701	GA	Teamcenter	Karol Nancka	Kamrul Hansen	Rev 01
DA600409066	Schematic	Teamcenter	Johan Roelofsen	Johan Roelofsen	Rev 01
N/A	All requirements for design (Design requirement, Functional requirement, Local requirement, location, Deviation to client requirement, Expected maturity, Delivery maturity)	N/A			N/A
N/A	Analysis Reports	N/A			N/A
N/A	Qualification documents	N/A			N/A
N/A	Standard	N/A			N/A
N/A	Equipment and tool	N/A			N/A
N/A	Flow assurance	N/A			N/A
N/A	Suppliers	N/A			N/A
N/A	Scope of work	N/A			N/A
N/A	Project plan	N/A			N/A
N/A	Contract	N/A			N/A
N/A	Budget	N/A			N/A

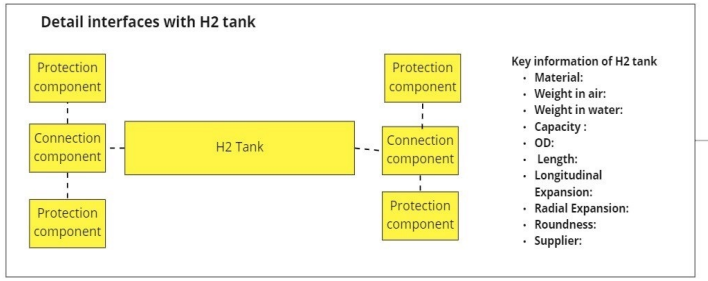
2. Deep Purple technology

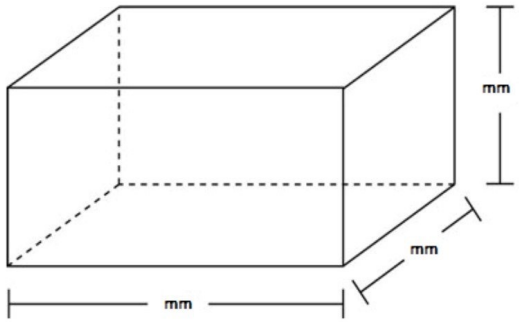


More information about dynamic behavior of Deep Purple please refer to the video (click on the red arrow or https://web.microsoftstream.com/video/3216803e-1d55-4df5-b58b-04f959abced1)



3. Interfaces between subsystems/components of H2 Storage module

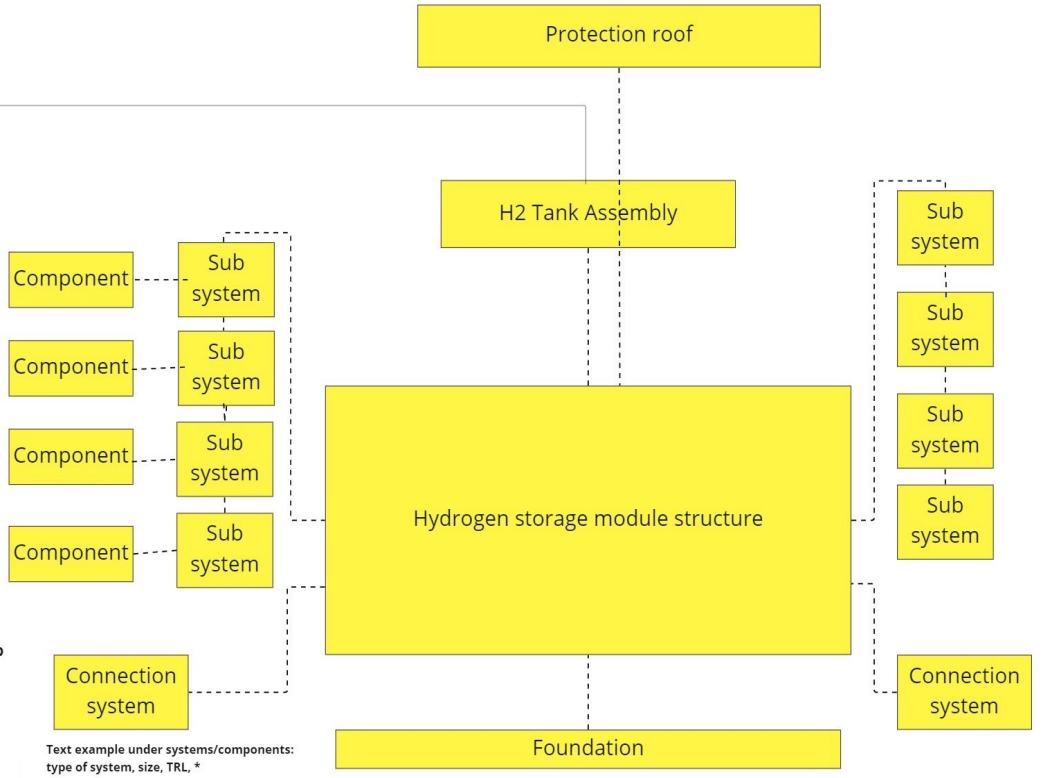




H2 storage assembly

KPPs:
- Design pressure for tank:
- Number of pressure cycles:
- Base volume of H2:
- Life time:
- Water depth:
- Temperature range:
- Total dry weight:
- Weight in subsea:

Key Info:
- Foundation:
- Overtrawlable design
- Installation method: Heavy lift Vessel/ alternative: Subsea towing
- Schematic DA600409066
- TRL is EU TRL scale
- " * " means the illustration is scaled up



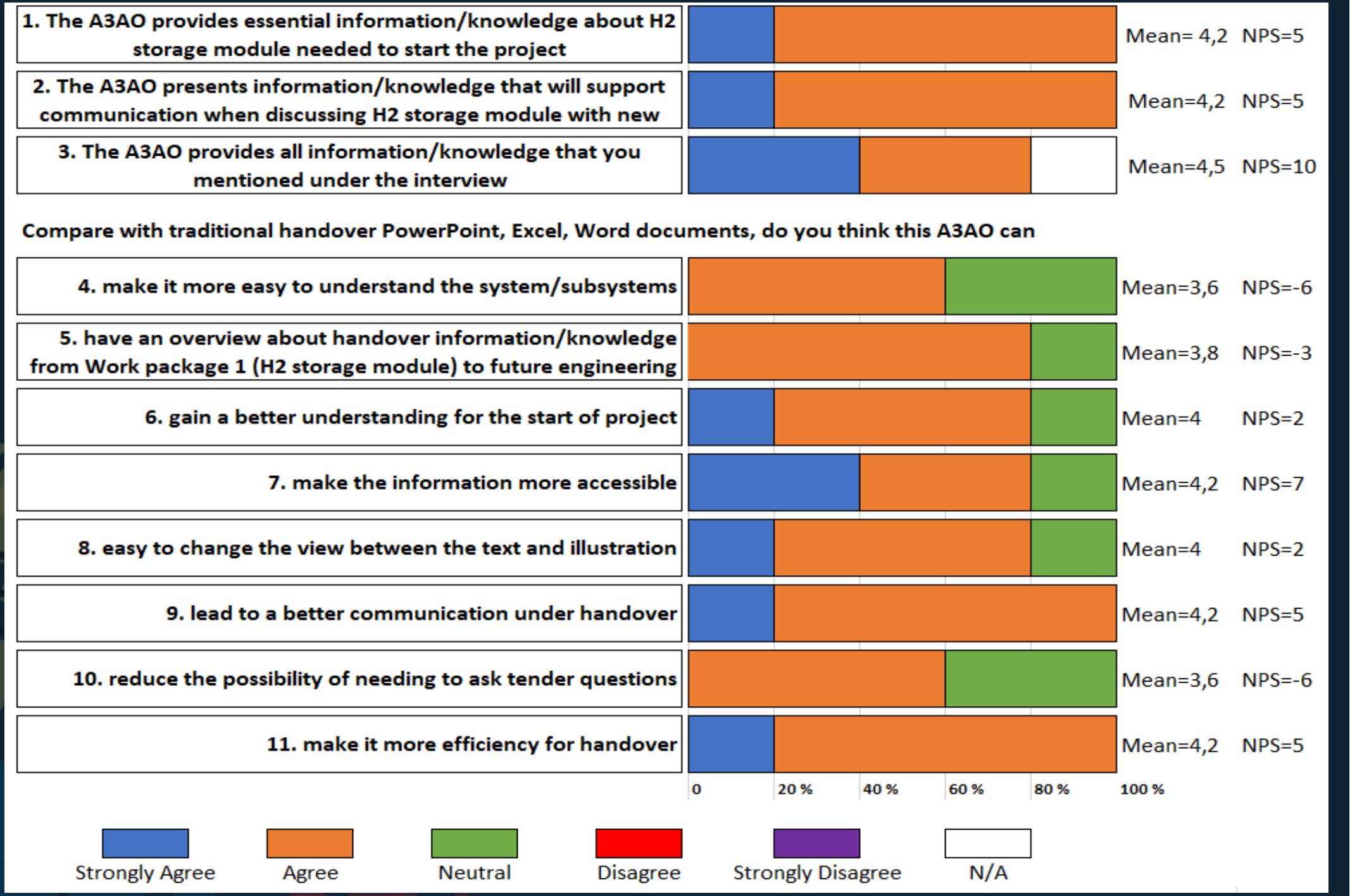
Text example under systems/components: type of system, size, TRL, *

Verification and Validation

- From the testing workshop, *participants*' points of view
- From the *user* point of view
- From the *management'* s point of view
- From an *expert* point of view

Results

Participants' points of view



Results

- **From the user point of view, this tool is easy to use and facilities knowledge transfer efficiency.**

  “I planned to use 30 minutes to explain, but in the end, I was able to spend only 10 minutes using this A3AO. Now I see the value of A3AO. ”

Results

- **From the management`s point of view, this tool is productive and worth investing time in.**

“We have been very busy but supporting this definitively helps me/us get less busy and more productive so squeezing that time for these sessions to support was motivating and worth it! This is great work! ”

Results

- **From an expert point of view, this tool is useful, but it requires maintenance as the project progresses.**

“It is very good to have not only the subsystem view but also including overall system. I think it would be useful for the future engineering team. The biggest challenge might be maintaining. For example, if the documents are not ready yet, make sure to update them.”

Discussion and Conclusion

Focusing on improvement

Catalog	Main Concerns
Maintenance	Installation of the system
	TRL
	Update it according to the project
	Update during project execution, for example, Part 1
	Revision control: risk of using an old version
New part	Abbreviation
	Traceability of requirements (Link to input documents)
	Cover all aspects

SE method - *"It is important to influence people when involving stakeholders in this case" – One director of the case company*

A3AO – application for efficient knowledge transfer of technological know-how in innovative complex systems development

Limitation acknowledgment & Future research

The solution has become an official tool released in the company.

Thank you!

Contact: yangyang.zhao@sfe.uio.no