



34th Annual **INCOSE**
international symposium

hybrid event

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Conceptual modeling for Early-Phase Decision-Making in the Maritime Industry

2-6 July 2024

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Authors

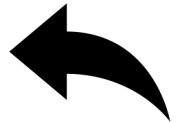
Magnus Grønningsæter



Siv Engen



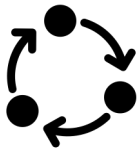
Agenda



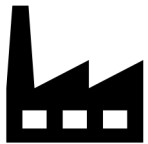
Background



Research question



Research methods



Industry Case



Discussion and Conclusion

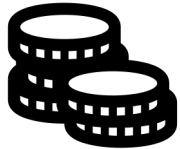
Motivation



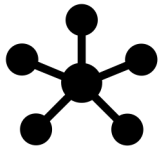
Strict regulatory requirements



Reduce emissions and carbon footprint



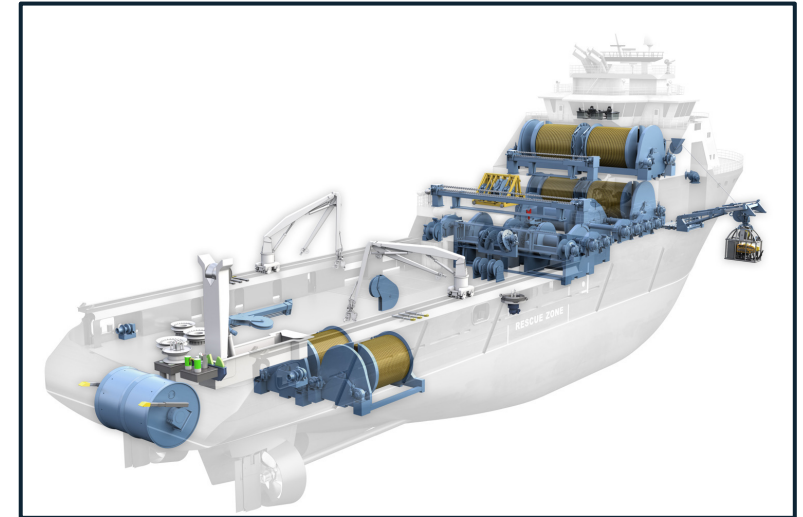
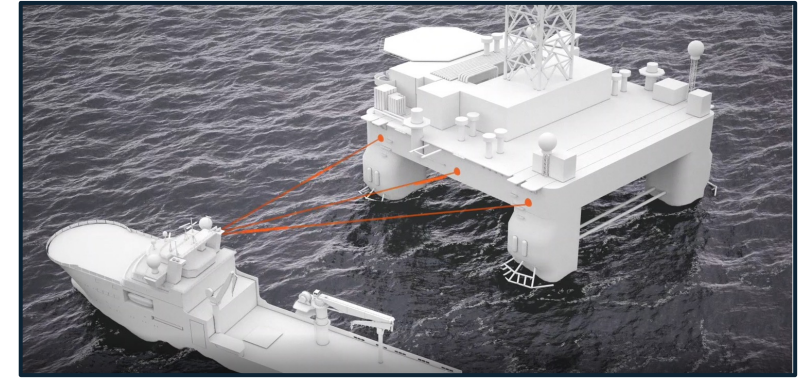
Competitive market



Manage increased complexity

Company of research

- **World leader in maritime technology**
- **Operating in 34 countries worldwide**
- **Delivers a comprehensive range of advanced maritime solutions**



Problem statement

- Delivery pressure and time constraints
→ **Rushed decisions**
- Inadequate execution of current processes
→ **Challenges in coping with increasing complexity**
- Lack of formal processes for early-phase decision-making in complex projects
→ **Cost overruns and poor design decisions**

Research Question

How can the application of conceptual modeling support the Company in Early-Phase decision making?

- a) What are the main challenges of the current processes in terms of early-phase decision-making in the Company?**
- b) How can conceptual modeling be applied to support the Company in early-phase decision-making of a shaft generator concept?**
- c) How does conceptual modeling support the Company in the challenges identified in RQ a)?**

Research method

Industry-as-laboratory

Exploration

Purpose:

- Identify current challenges

Data collection:

- Semi-structured interviews
- Observation
- Document Analysis

Industry Case: Application

Purpose:

- Apply conceptual modeling in company

Data collection

- Observation

Validation

Purpose:

- Validation of the conceptual modeling approach

Data collection:

- Post-Industry Survey
- Observation

Exploration



Semi-structured interviews



Document analysis



Observations

Findings current challenges

- Nonsufficient decision-making processes
 - Late involvement of systems engineering
 - Poor communication between departments
- **Lack of stakeholder understanding and poor need definition**

Industry case



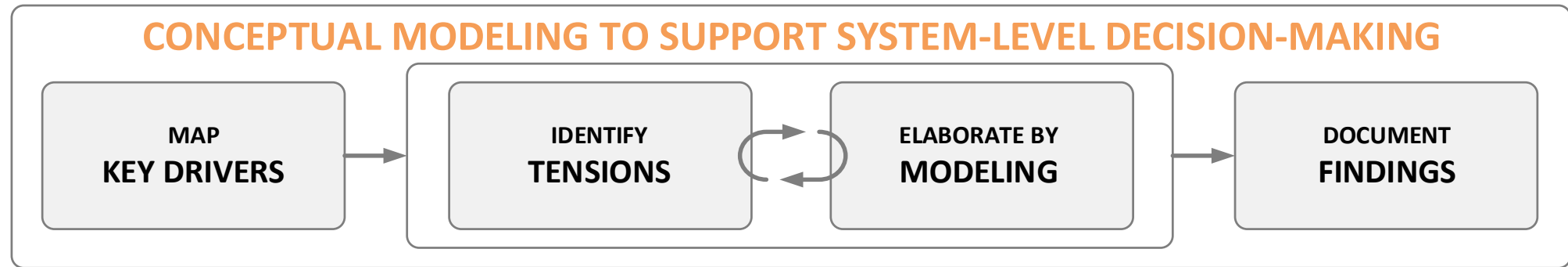
Application of conceptual modeling in project



Observations

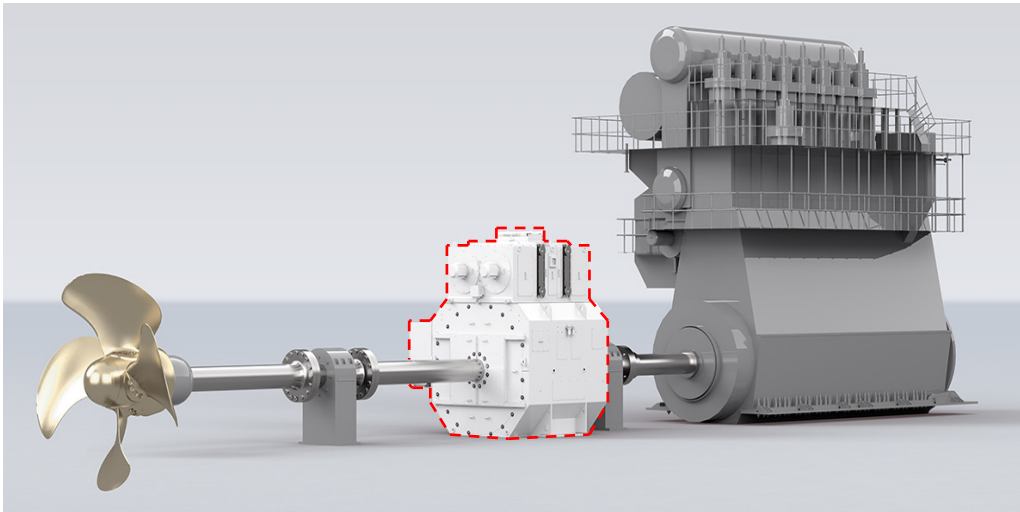
Industry case – conceptual modeling

” Models that are sufficiently simplified to help architects understand, reason, communicate and make decisions ”



Industry case – shaft generator

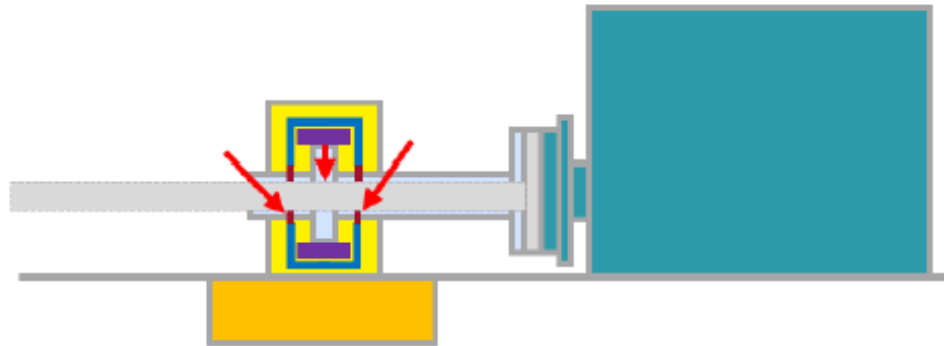
Develop a new innovative type of shaft generator that clamps around the existing shaft line



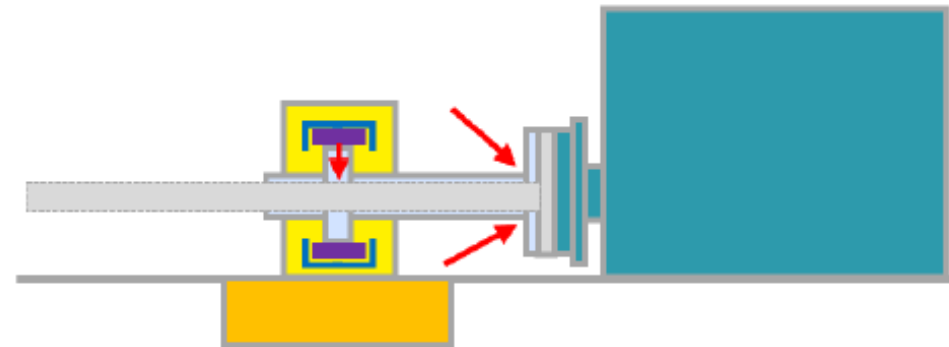
- ⊕ Reduce emissions and carbon footprint
- ⊕ Enhances operational flexibility and efficiency at different speeds
- ⊕ Decrease fuel consumption and maintenance cost

Industry case - Concepts

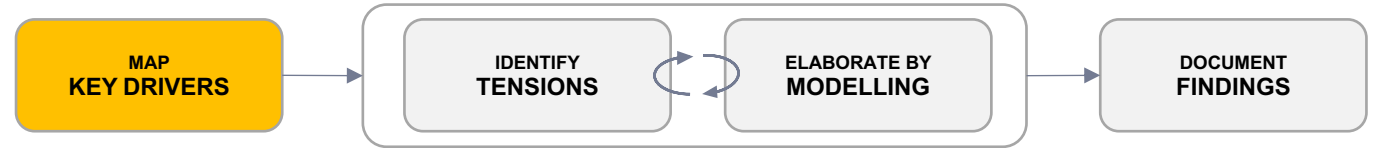
A) Flywheel Coupling with Bearings



B) Flywheel Coupling without Bearings



Key driver map



Interviews of 3 key stakeholders



Analyzing documents

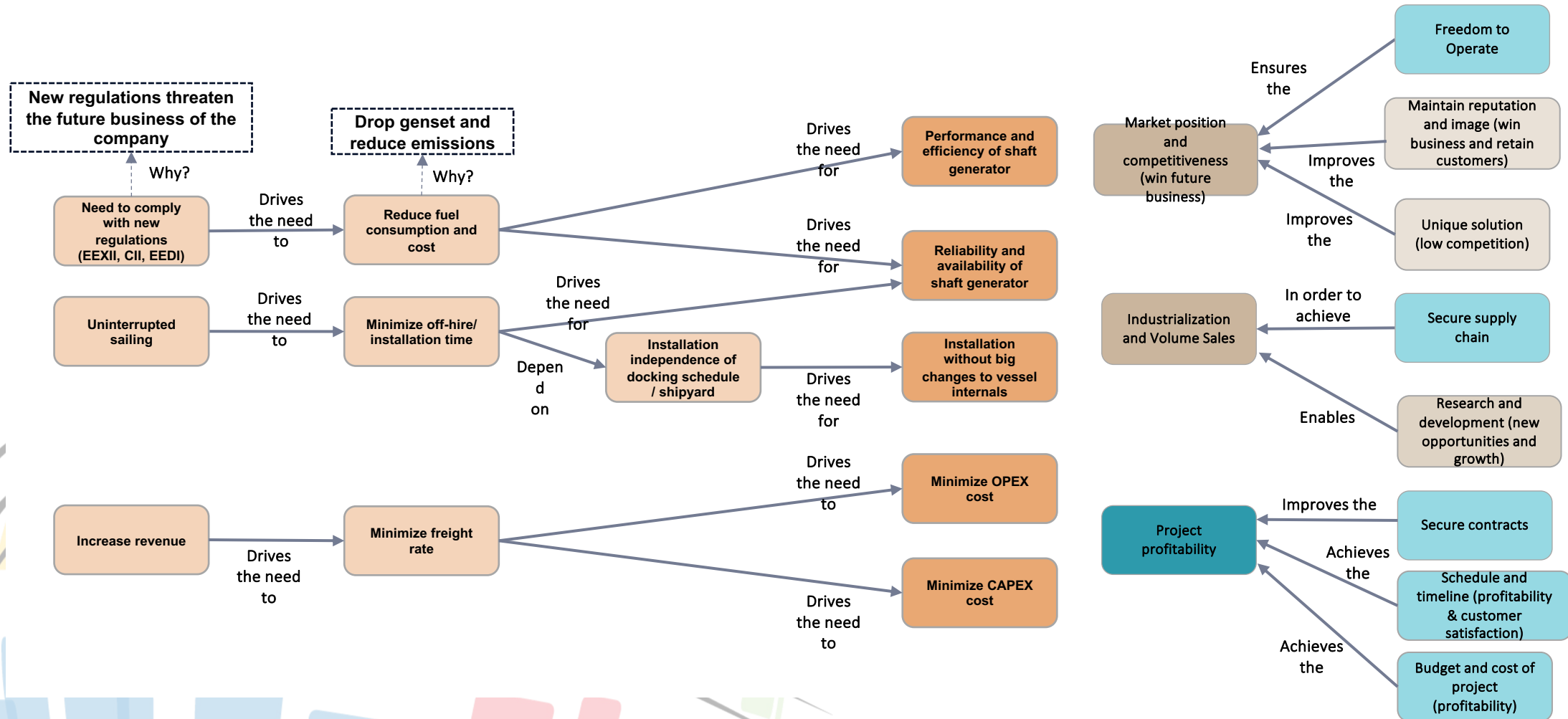
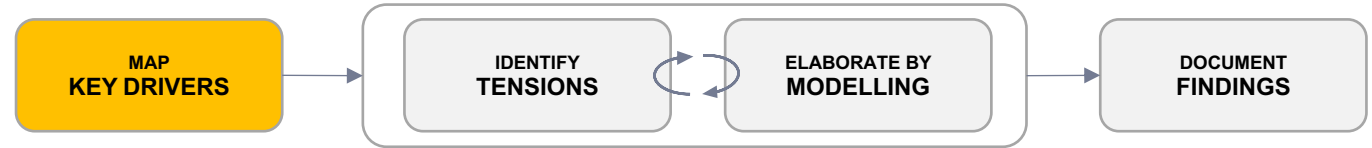


Work sessions with domain experts

23 drivers

8 drivers

Key driver map



2-6 July 2024

Legend

Relationship

Explanation

Explanation

Customer Driver

Customer Key Driver

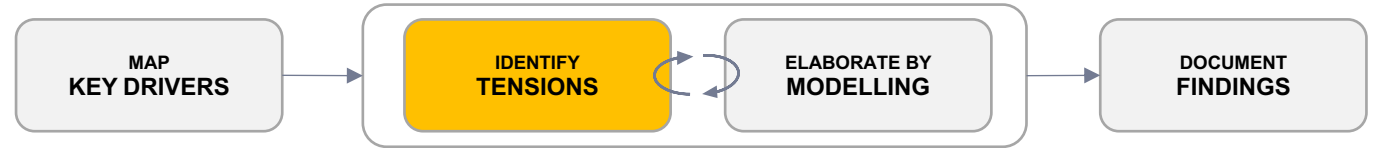
Project Driver

Project Key Driver

Company Driver

Company Key Driver

Tensions



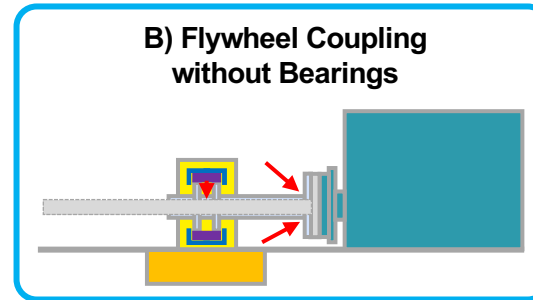
Minimize OPEX cost

Reliability and availability of shaft generator

Performance and efficiency of shaft generator

Installation without big changes to vessel internals

Minimize CAPEX cost



DRIVES

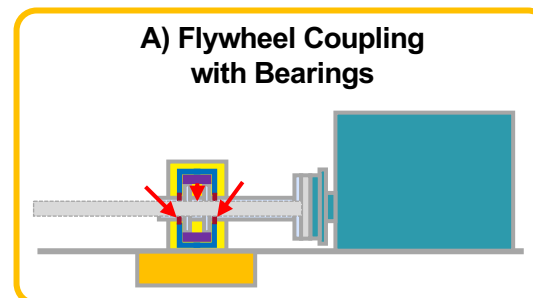
Industrialization and Volume Sales

DRIVES

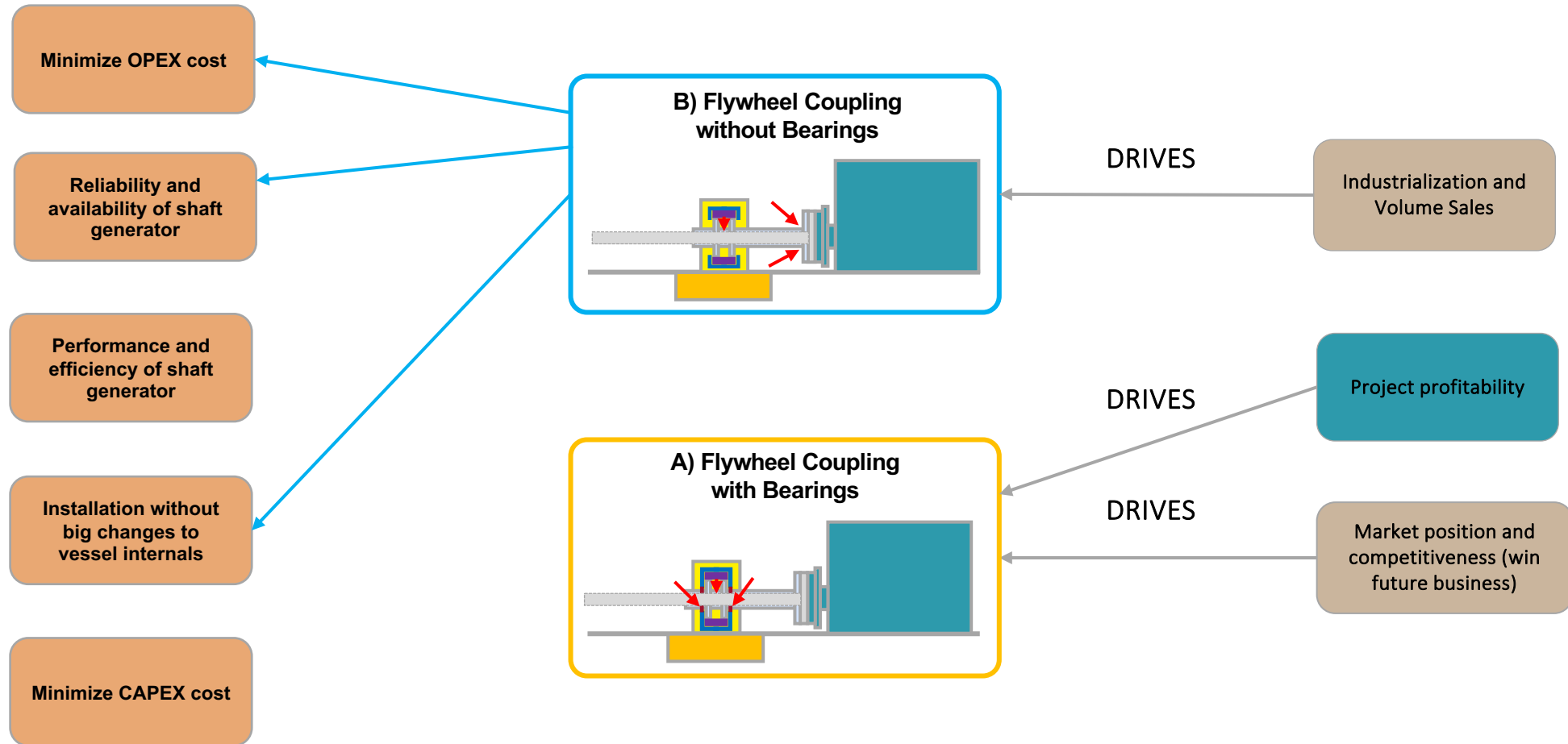
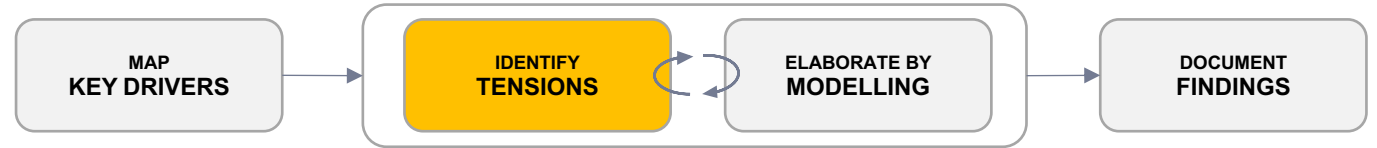
Project profitability

DRIVES

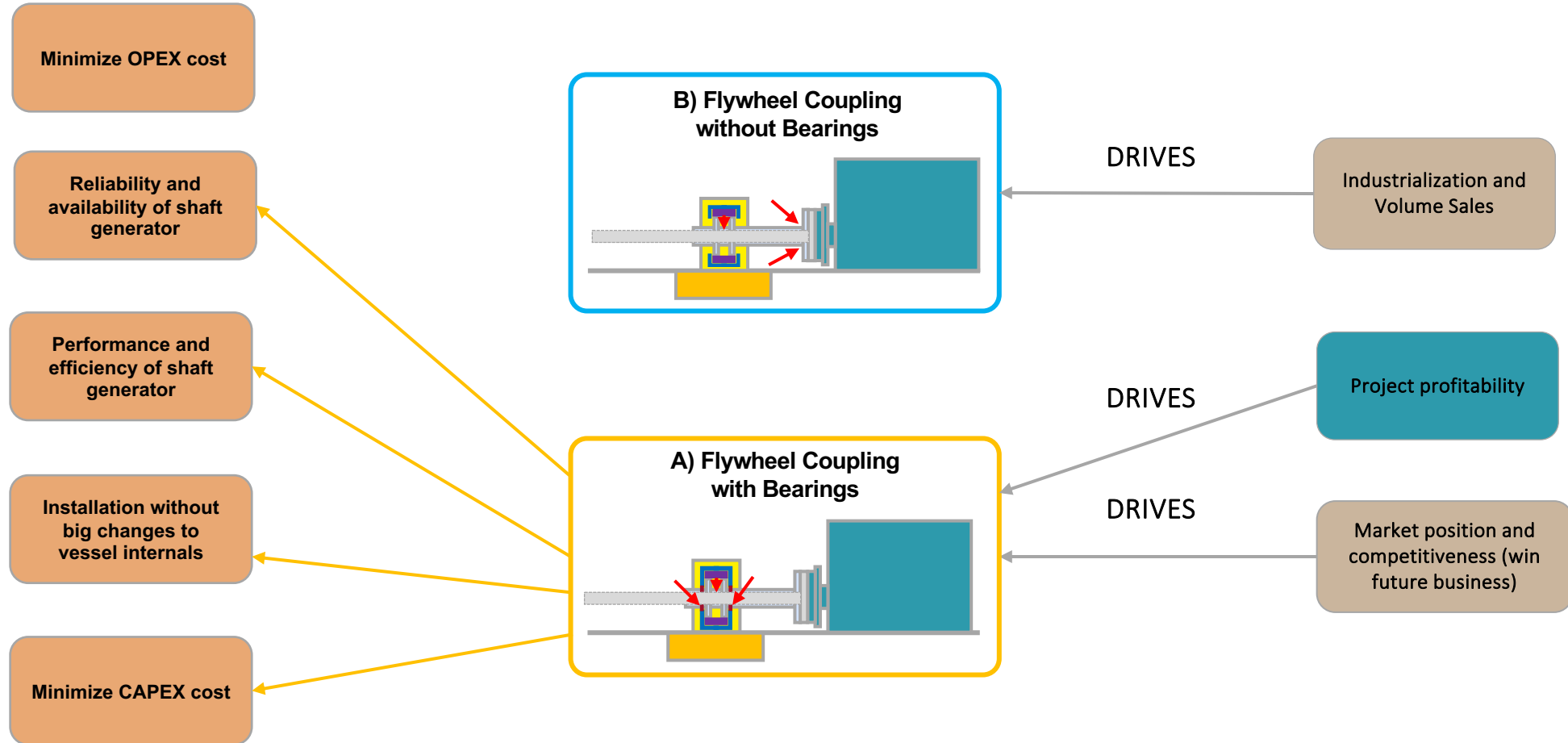
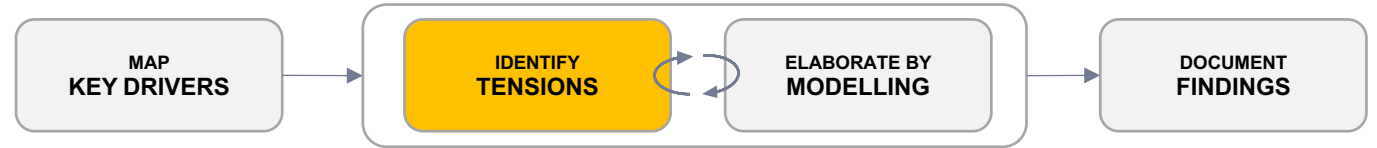
Market position and competitiveness (win future business)



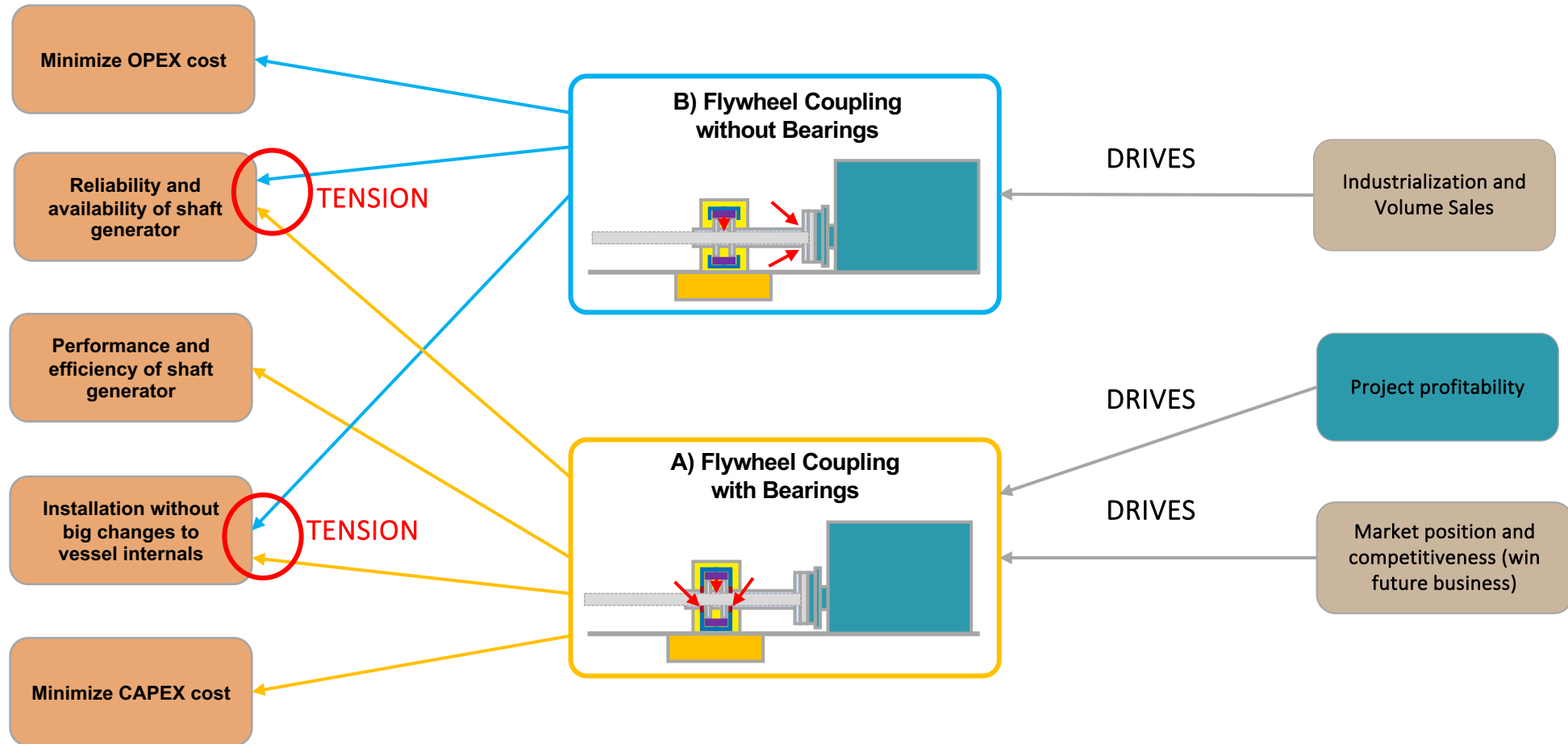
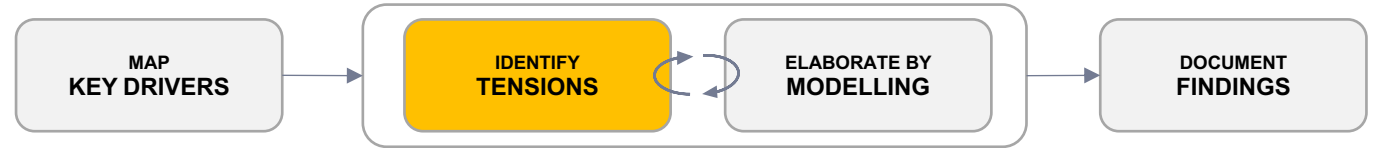
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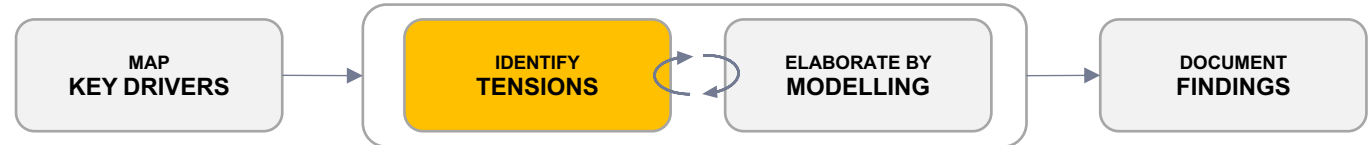
Tensions



Tensions

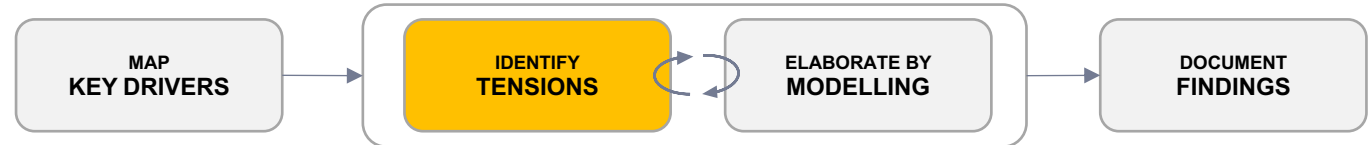


Pugh Matrix



		CONCEPT B		CONCEPT A	
Categories	Criteria	Priority Weight (1-5)	Weight (1-5)	Flywheel Coupling without Bearings	Flywheel Coupling with Bearings
Cost	Product cost	3	5	1	5
	Engineer to order		3	3	5
	Installation cost		2	3	5
	Maintenance cost	2	2	5	1
Number of criteria	3		SUM	4,8	5,5
Alignment	Magnetic Pull	3	4	1	5
	Maintenance		4	5	2
	Vibration / Displacement		3	1	5
	Ease of shaftline integration	5	5	1	5
Number of criteria	4		SUM	10,0	21,3
Ease of Installation	Installation time	5	5	3	4
	Mechanical complexity		4	5	3
	Low off-hire		5	1	5
	Special Tooling		3	1	5
	Scalability		3	3	3
Number of criteria	5		SUM	13,0	20,3
Flexible shaftline coupling	Flexibility of integration	3	4	1	1
	Weight on shaft line		3	1	5
Number of criteria	2		SUM	3,4	10,9
Weighted Average:				25 %	49 %

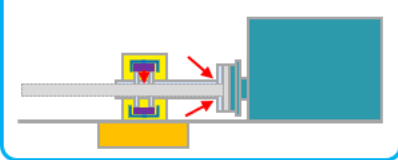
Pugh Matrix



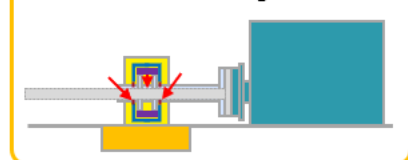
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Reliability and availability of shaft generator

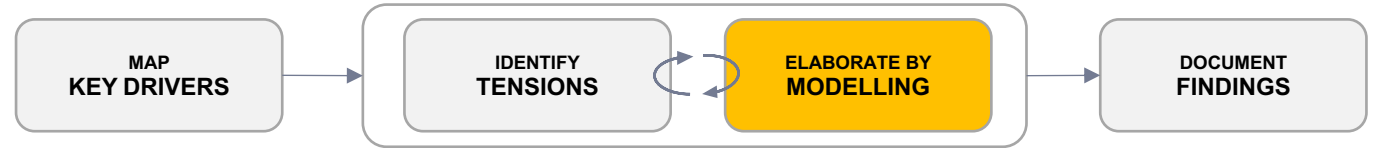
B) Flywheel Coupling without Bearings



A) Flywheel Coupling with Bearings



Modelling

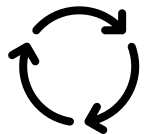


Elaborated in two type of models

- **Abstract workflows**
- **Timelines**

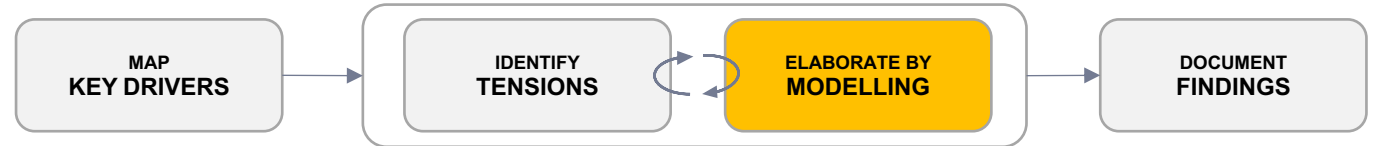


Work sessions with domain experts

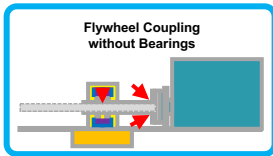


Iterations – refine and reviews

Modelling



CONCEPT B



Legend

Workflow



Activity

Start

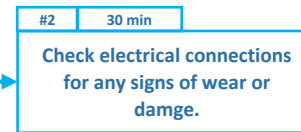
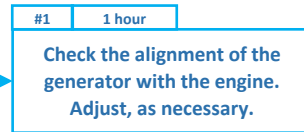


End

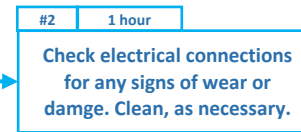
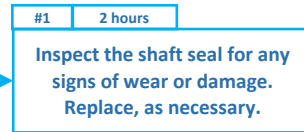


Maintenance

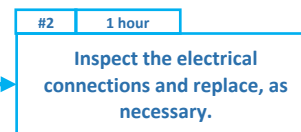
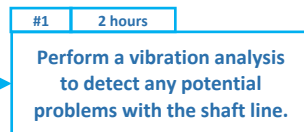
Weekly



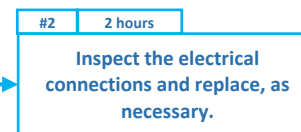
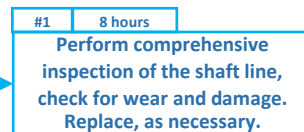
Monthly



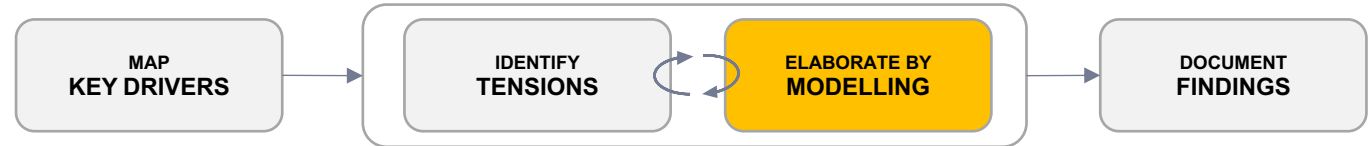
Quarterly



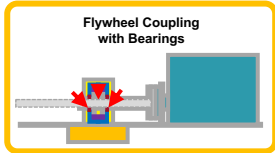
Yearly



Modelling

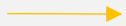


CONCEPT A



Legend

Workflow

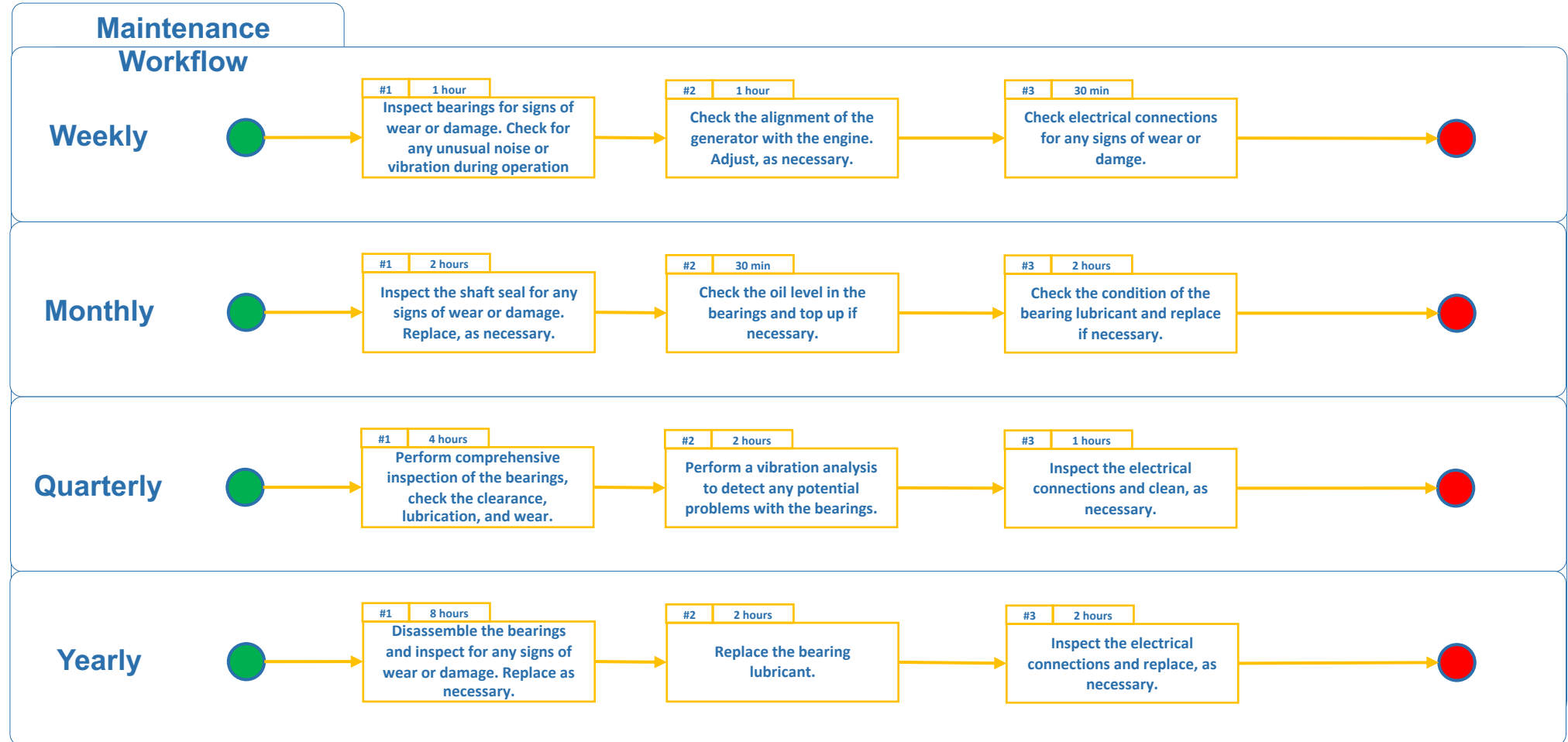


Activity

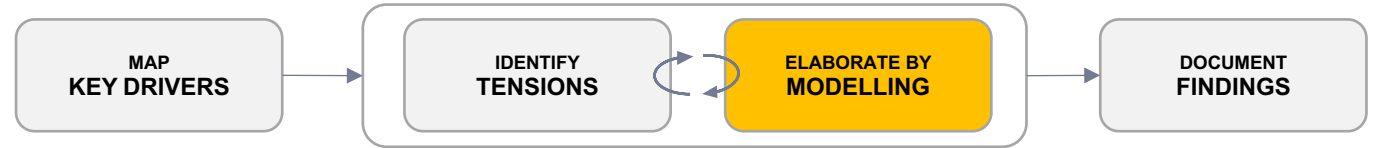
Start



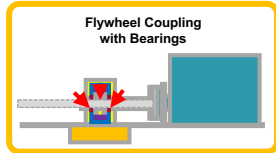
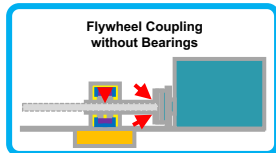
End



Modelling

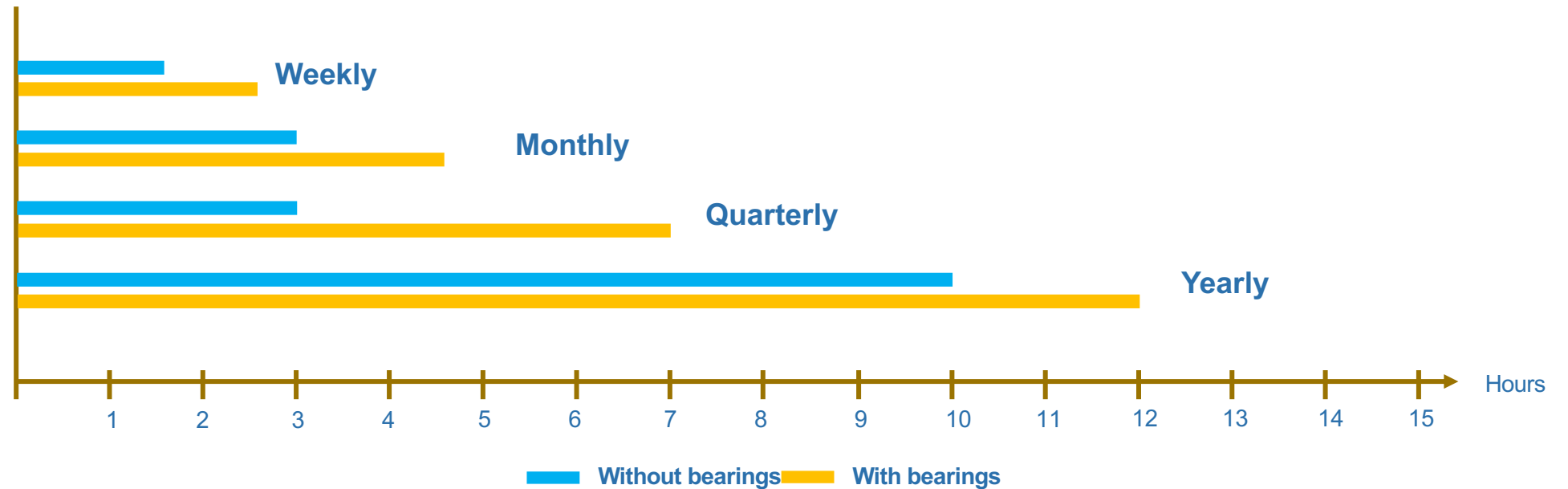


CONCEPT B

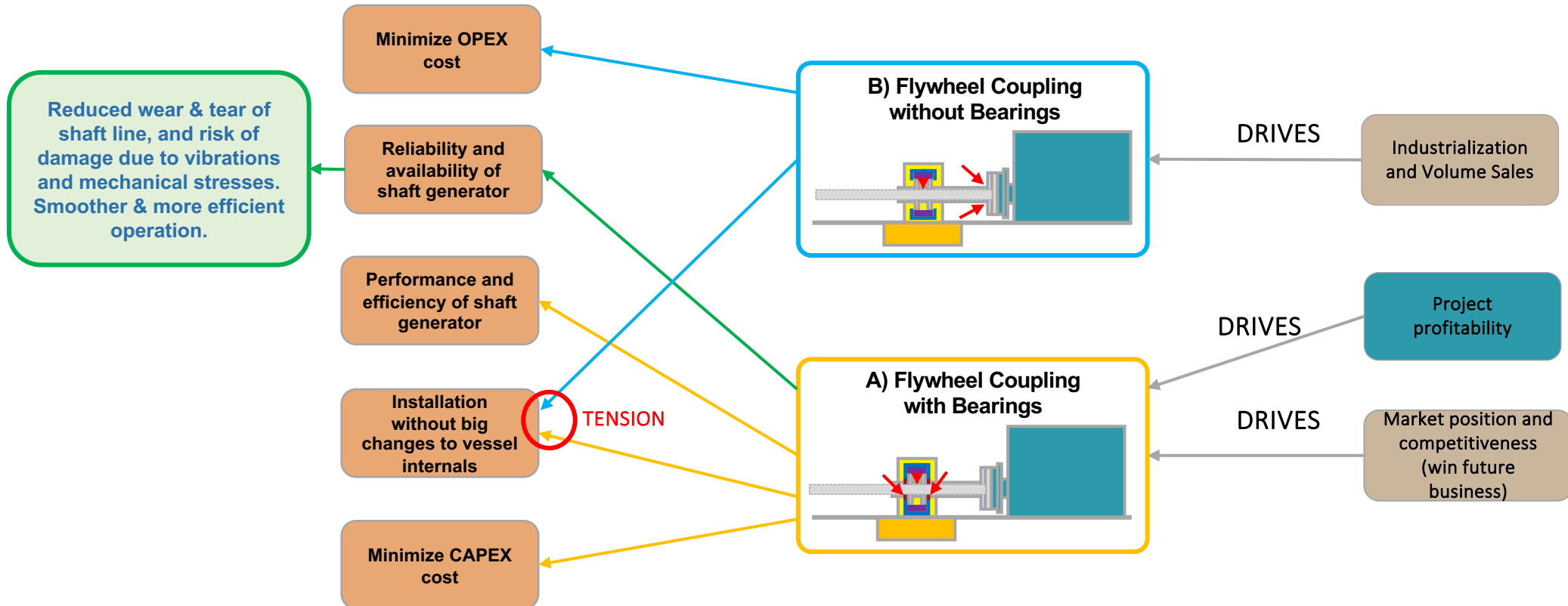
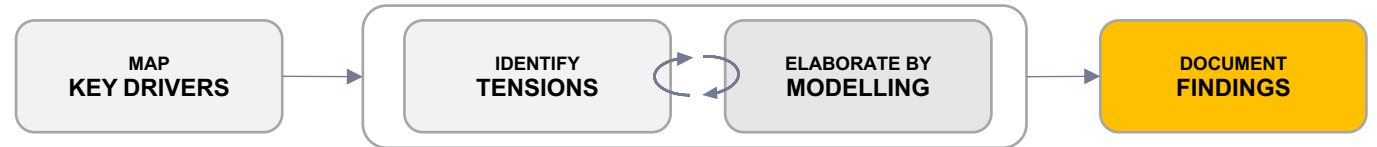


CONCEPT A

Timeline



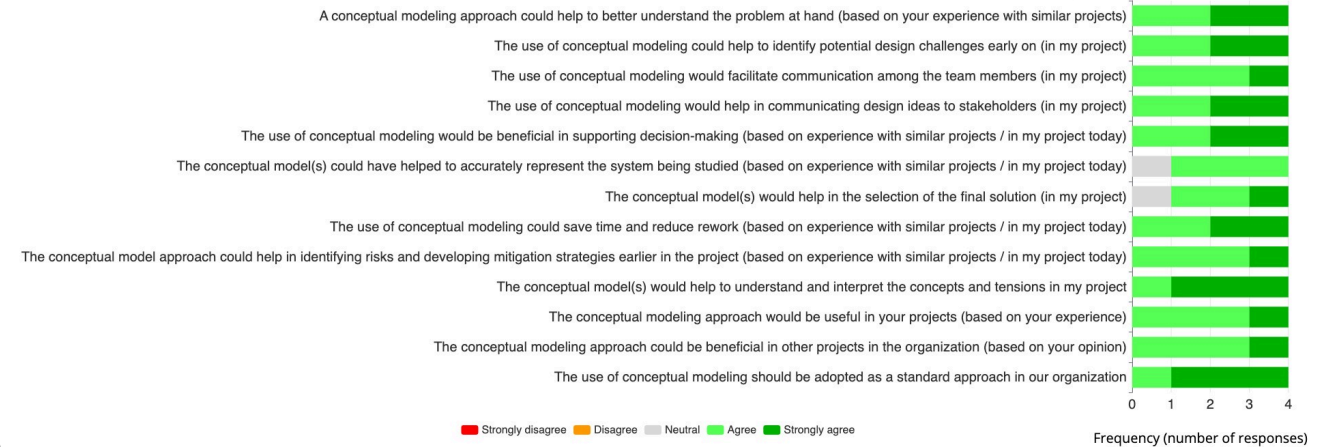
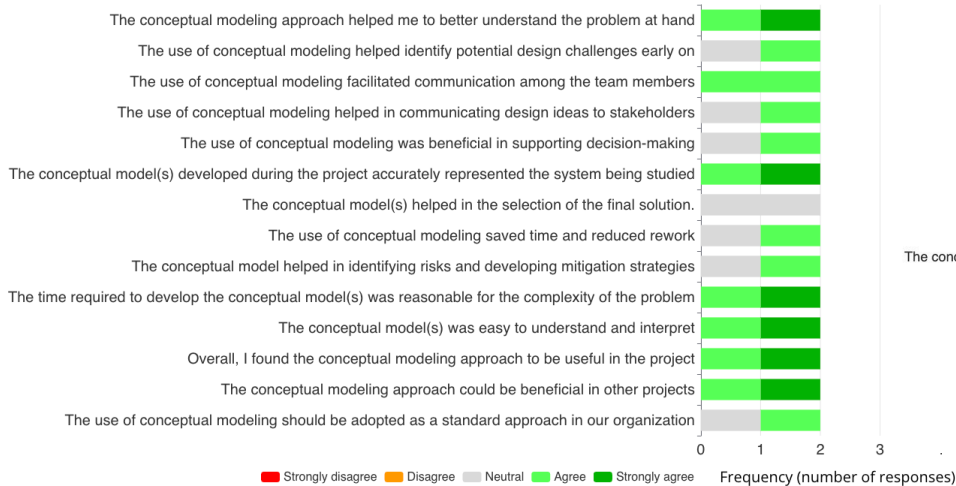
Document






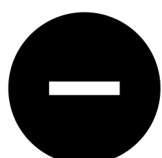
Validation



Survey

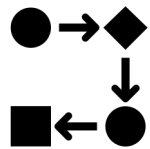


Validation

-  **Facilitate discussion, objective evaluation and informed decision-making**
-  **Conceptual models offers clarity, are easily comprehensible and interpretable**
-  **Effectively facilitates communication between project team and external stakeholders**
-  **Concerns regarding abstraction, complexity management and evolving requirements**

Answering the research questions

RQ a) What are the main challenges of the current processes in terms of early-phase decision-making in the Company?



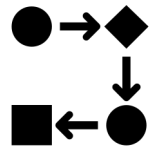
Need for a structured approach



Lack of clear understanding of the problem

Answering the research questions

RQ b) How can conceptual modeling be applied to support the Company in early-phase decision-making of a shaft generator concept?



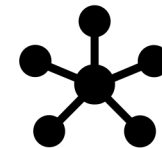
Structured approach



Detailing



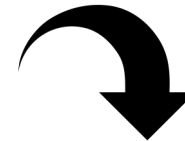
Visual



Manage complexity



Stakeholder alignment



Evolving requirements

Answering the research questions

RQ c) How does conceptual modeling support the Company in the challenges identified in RQ a)?



Supports understanding and informed decision making



Supports knowledge capture and sharing



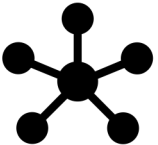
Facilitates continuous improvement in organization

Answering the research questions

RQ) How can the application of conceptual modeling support the Company in early-phase decision making?



Understanding and communication



Manage complexity

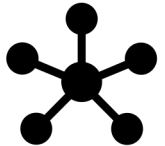


Informed decisions

Conclusion



Support early phase decision making



A structured approach to cope with complexity



Visualization for understanding and communication



Represent system and develop foundation for detailed models

Limitations and future research

Limitations and concern

- Single case in one company
- Limited participants number
- Time and resource constraints

Future research

- Enhance robustness
- Incorporate in industrial setting
- Deal with traceability and evolving requirements



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