31st Annual INCOSE international symposium
virtual event
July 17 - 22, 2021

Product portfolio mapping used to structure a mature sub-system with large variations

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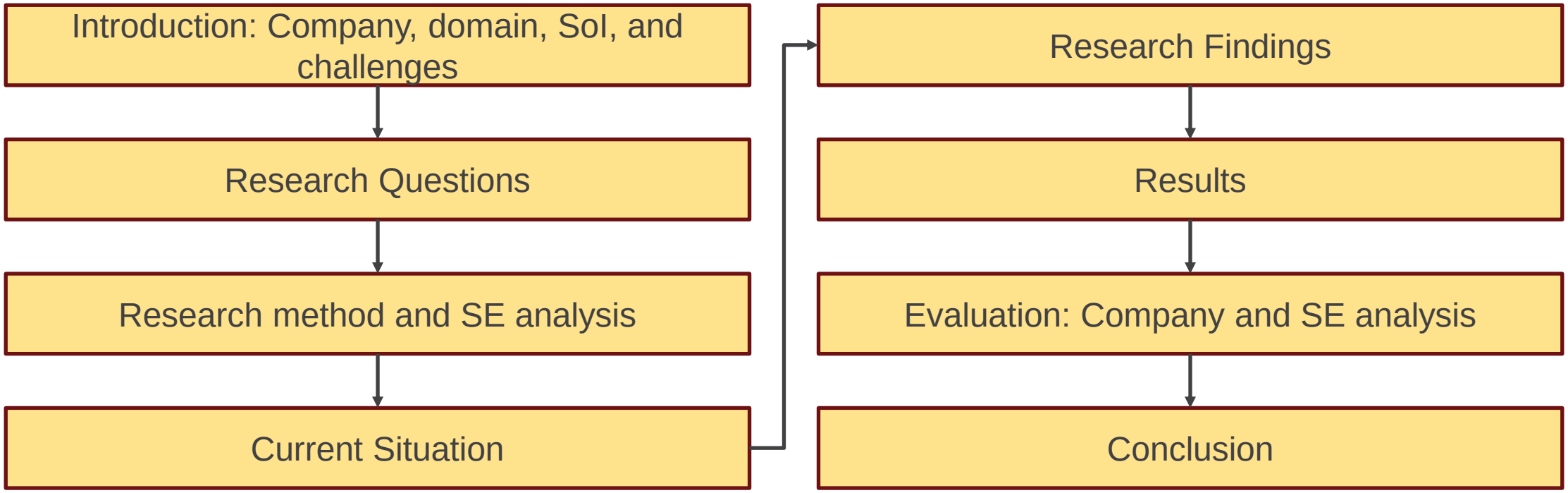
Who is presenting?

Background:

- Welding in the offshore industry.
- B.E. Mechanical Engineering.
- MSc. Systems Engineering.
- EFD Induction, USN, master thesis.
- Grasp Labs.

Presentation program



Context of the study

Company size

- 22 Countries.
- 1100 employees globally, 150 in Norway.
- Since 1996, delivered 20,000 solutions.

The investigated sub-system:

- HHT – Hand-Held Transformer
- 13000 sold since 1997.
- Approximately 1000 variants.
- 4 Standardized designs.

The problem statement

The company struggles to find a “lasting” solution to manage the 1000 variants; their main concern is the cost drivers and the product data that is incomplete and lacks consistency.

The opportunity for this thesis is to find a “lasting” solution for both the new and existing variants and evaluate how it impacts the operational efficiency for the company.

Research questions

1. What causes unpredictable product cost and uncertainty in product development for the organization?
    a. What are the needs in the company for a solution that handles product variance?
2. How can Systems Engineering thinking/methods help to reduce the experienced uncertainty inside the organization?
    a. How can a product structure that follows architectural principles improve operational processes in the workflow?
    b. How can the product portfolio analysis help organizations to increase efficiency in managing product variability?

Research method

Investigate

- Open Discussions
  - Engineering Manager
  - Industrialization Manager
  - Product Manager
  - Mechanical Engineering Manager

Understand

- Open interviews
  - Sales
  - Tech. Sales
  - Project Management
  - Engineering
  - Logistics
  - Product Management
  - Manufacturing (India)
  - Packaging
  - Aftersales
- Historical Sales Data
  - ERP Data
  - PDM Data
  - Sales orders
  - Specification sheet
- Interviews
  - R&D
  - Product Manager
  - Engineering Manager

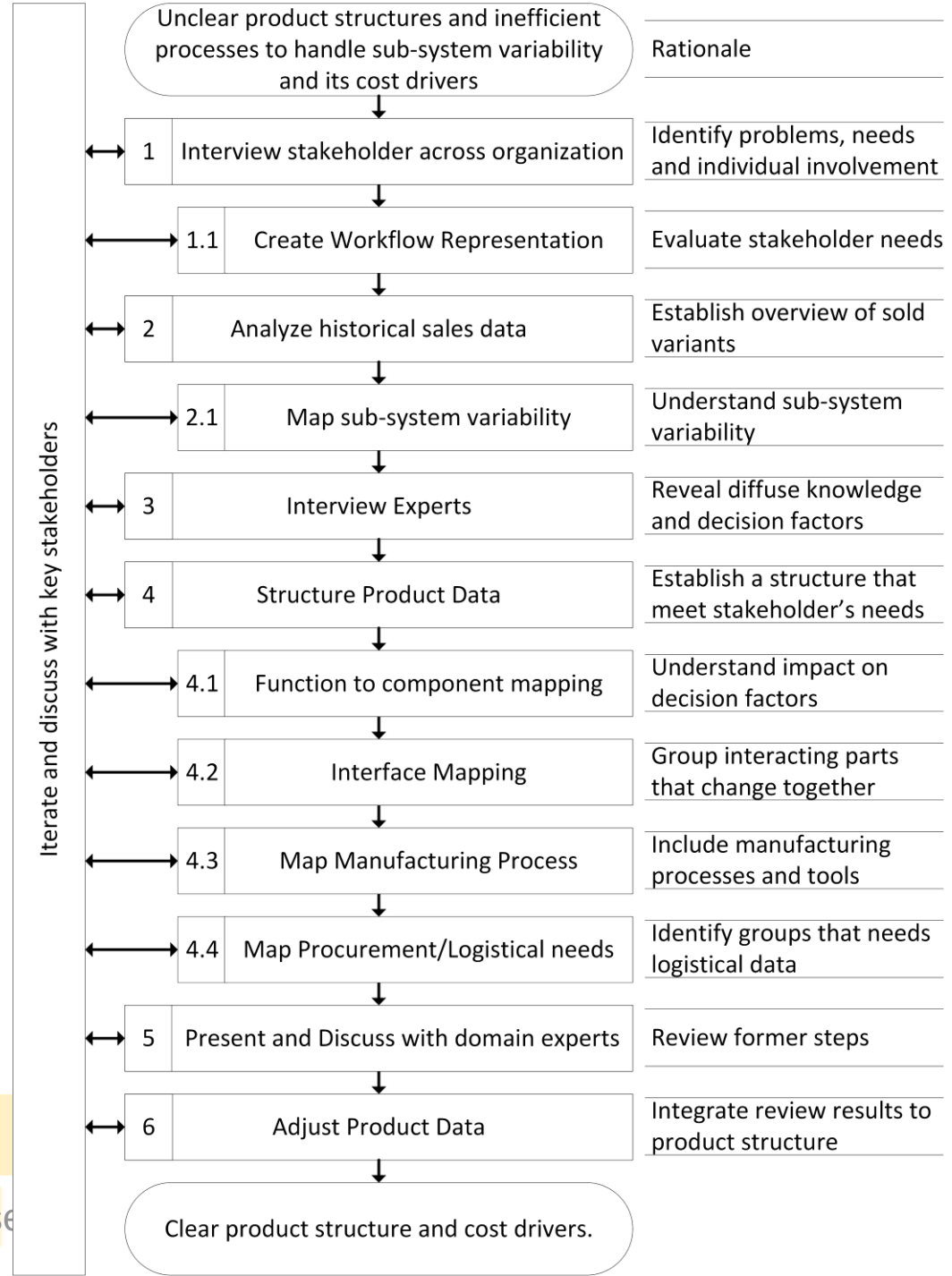
Explore

- Company-specific constraints
  - ERP
  - PDM
  - CAD
- Product Structuring
  - Function to component mapping
  - Interface management
- Operational efforts mapping
  - Logistics
  - Manufacturing
- Presentation and adjustments
  - Engineering Manager
  - Industrialization Manager
  - Product Manager

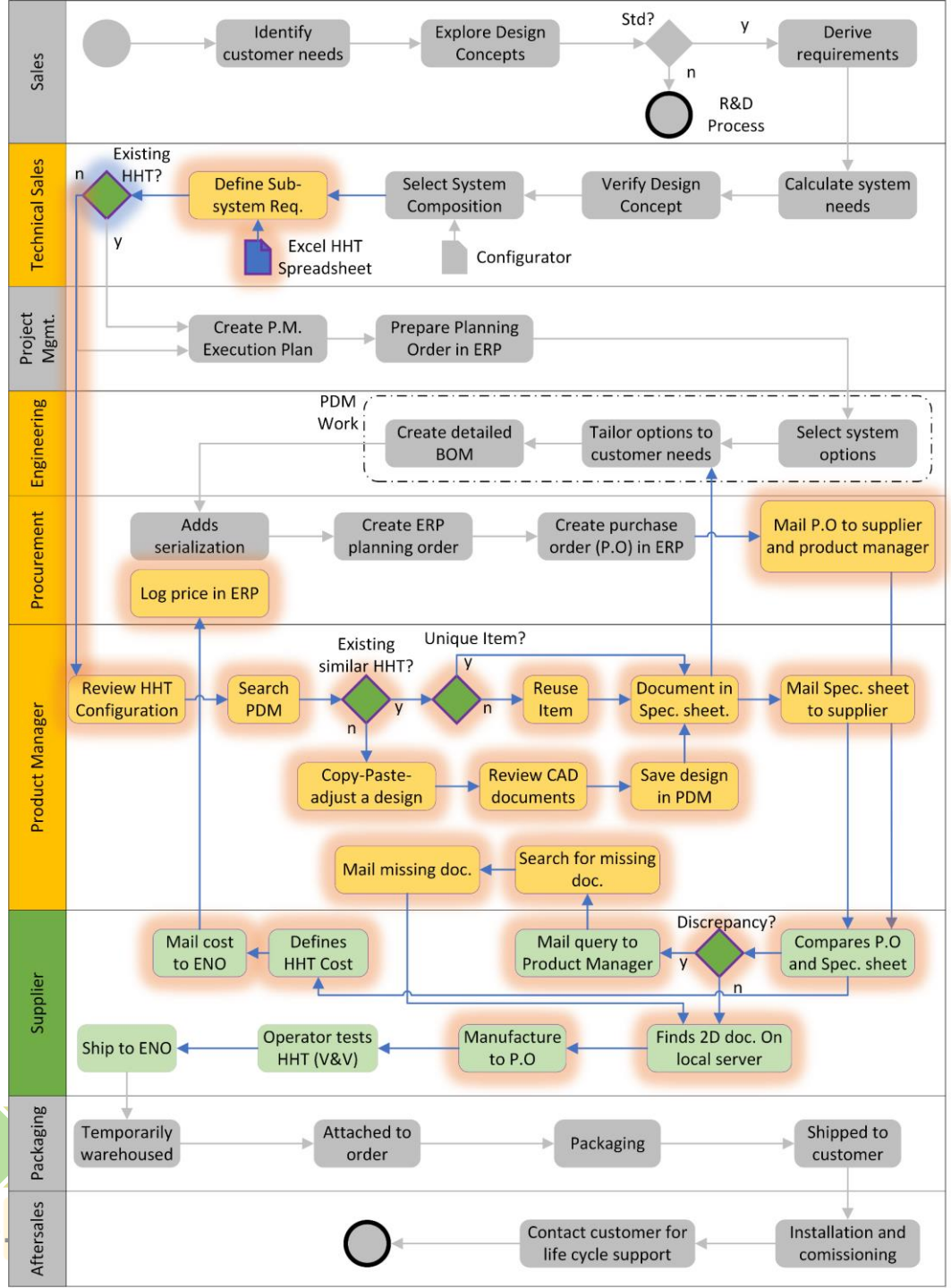
Evaluate

- Predefined questions
- Open discussion with feedback
  - Engineering Manager
  - Industrialization Manager

Analysis


Iterate and discuss with key stakeholders
Unclear product structures and inefficient processes to handle sub-system variability and its cost drivers
Rationale
1 Interview stakeholder across organization
Identify problems, needs and individual involvement
1.1 Create Workflow Representation
Evaluate stakeholder needs
2 Analyze historical sales data
Establish overview of sold variants
2.1 Map sub-system variability
Understand sub-system variability
3 Interview Experts
Reveal diffuse knowledge and decision factors
4 Structure Product Data
Establish a structure that meet stakeholder's needs
4.1 Function to component mapping
Understand impact on decision factors
4.2 Interface Mapping
Group interacting parts that change together
4.3 Map Manufacturing Process
Include manufacturing processes and tools
4.4 Map Procurement/Logistical needs
Identify groups that needs logistical data
5 Present and Discuss with domain experts
Review former steps
6 Adjust Product Data
Integrate review results to product structure
Clear product structure and cost drivers.

Current Situation

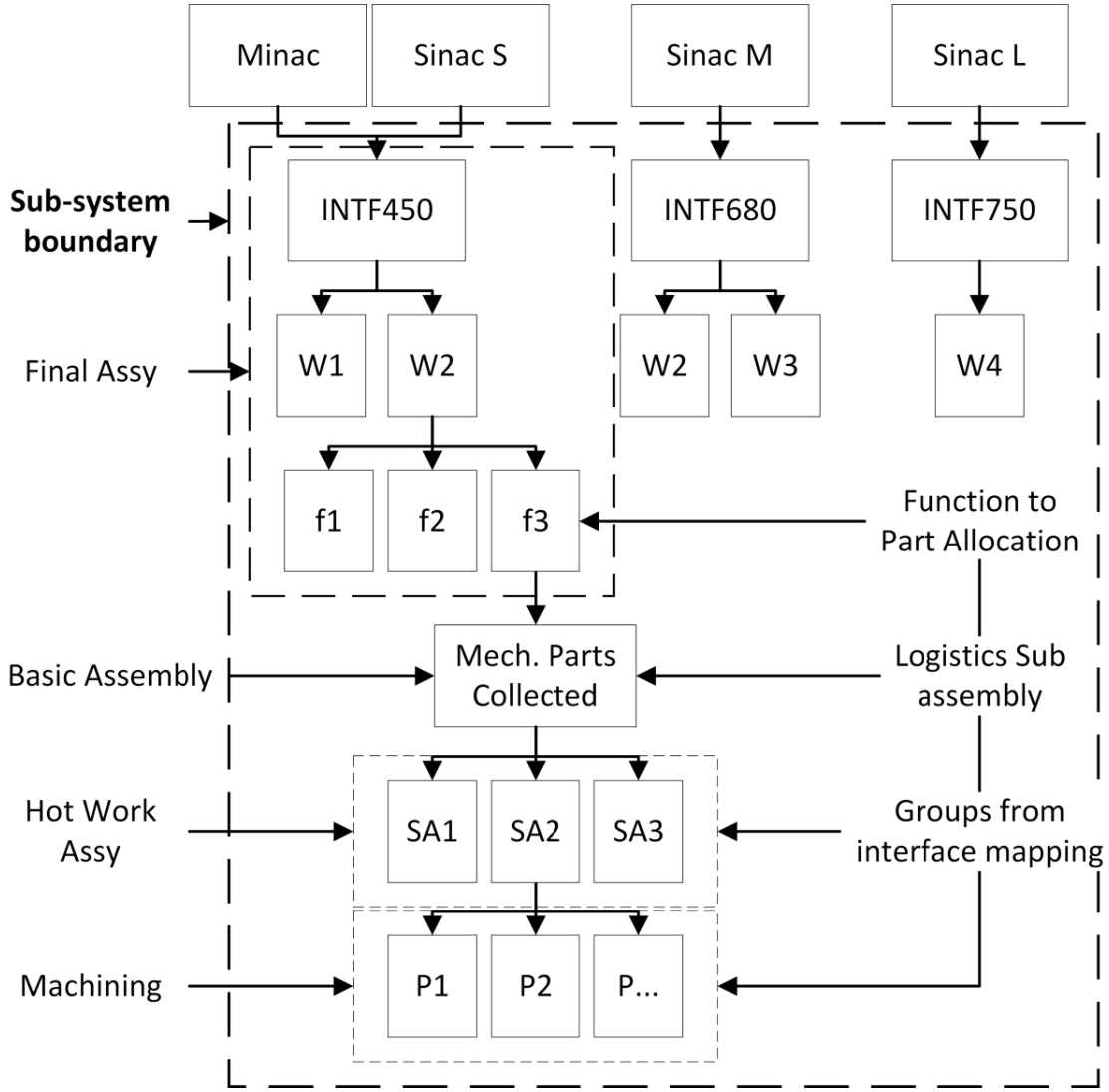


Research findings

Table 1 Data relation to main stakeholders

		Product Manager	Procurement	Supplier
Product Data	Product Architecture	x		
	BOM	x		x
	2D/3D documents	x		x
	Item attributes	x	x	
Logistics Data	Cost structure		x	x

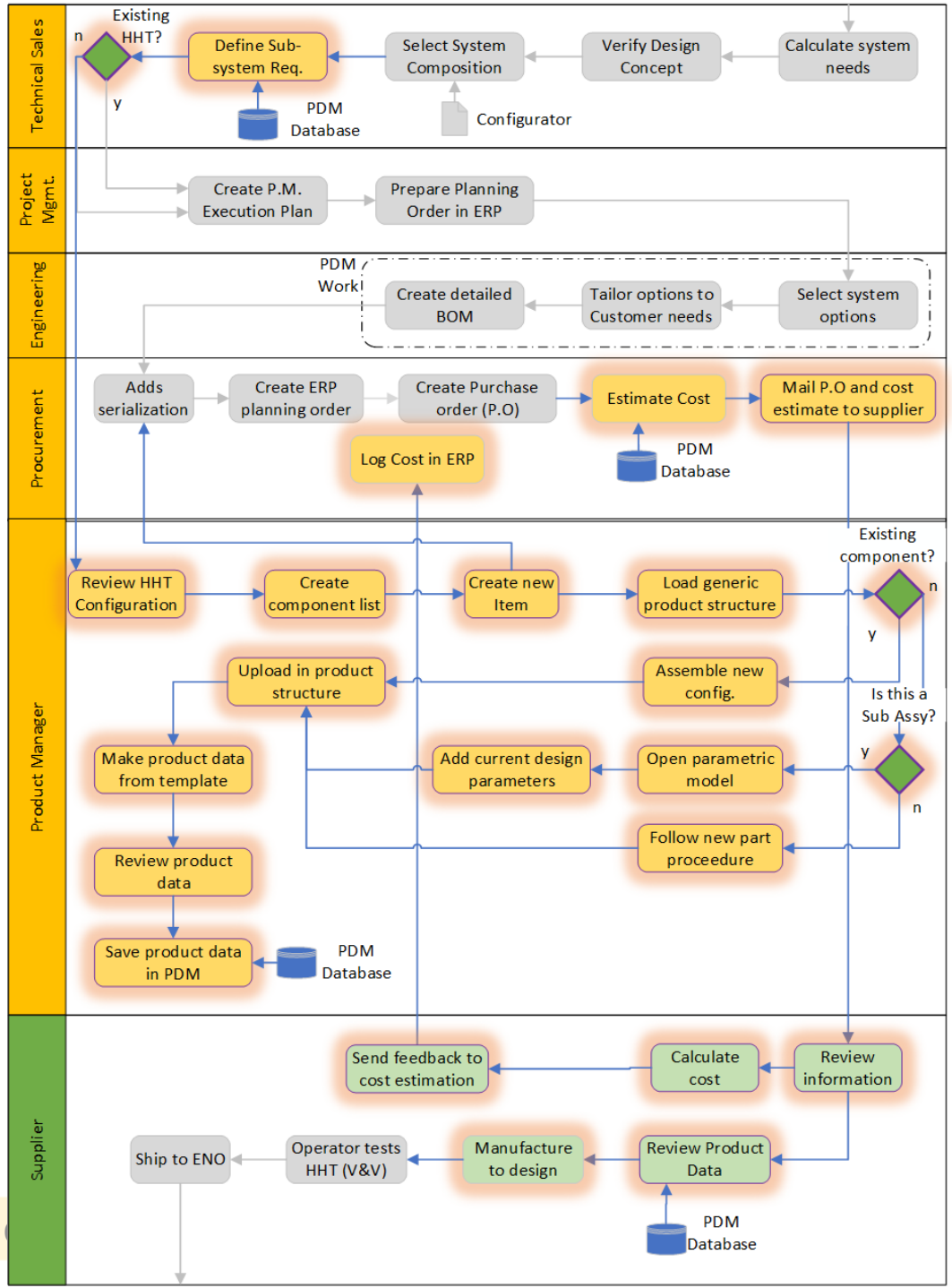
Product structure

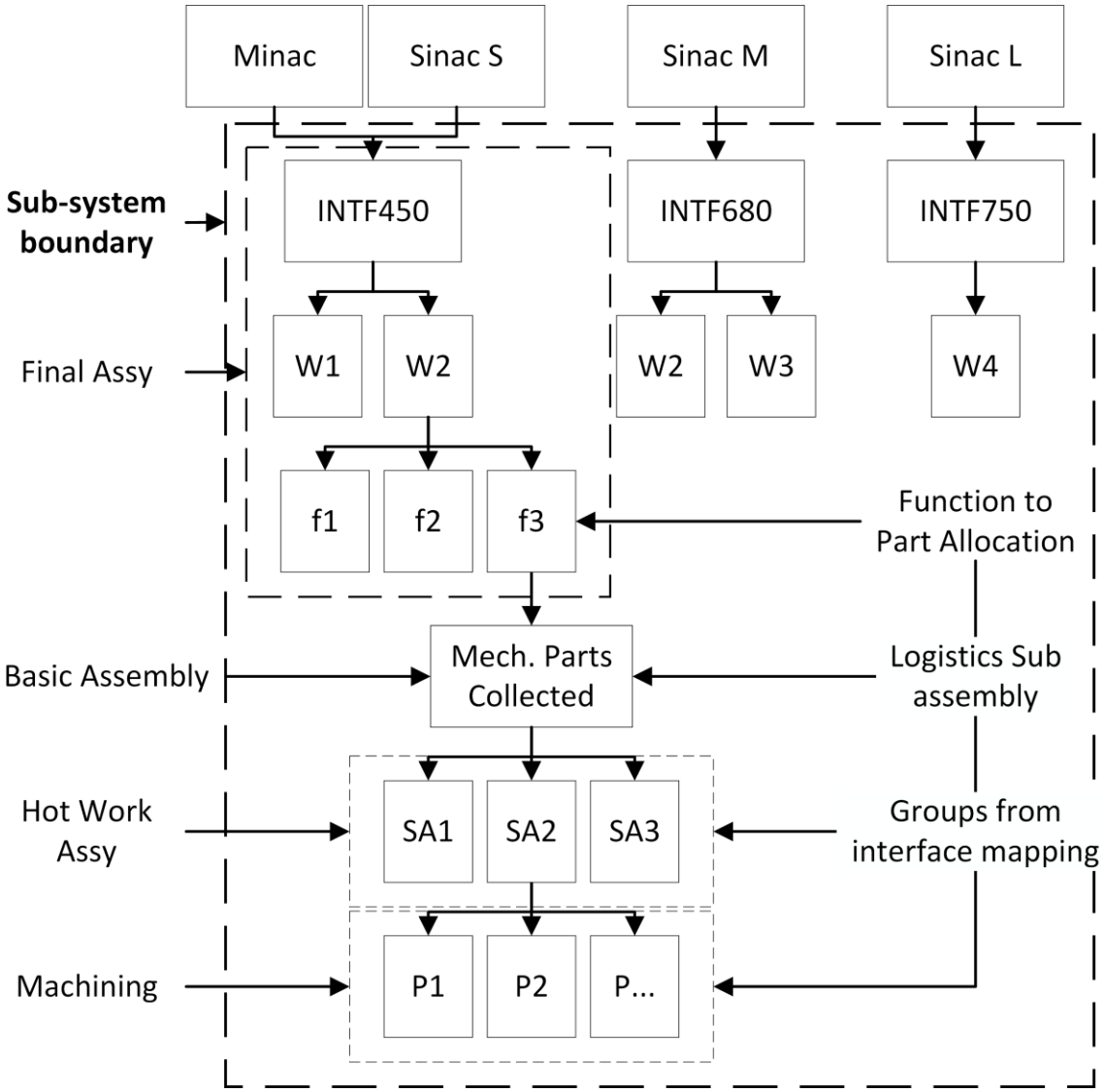


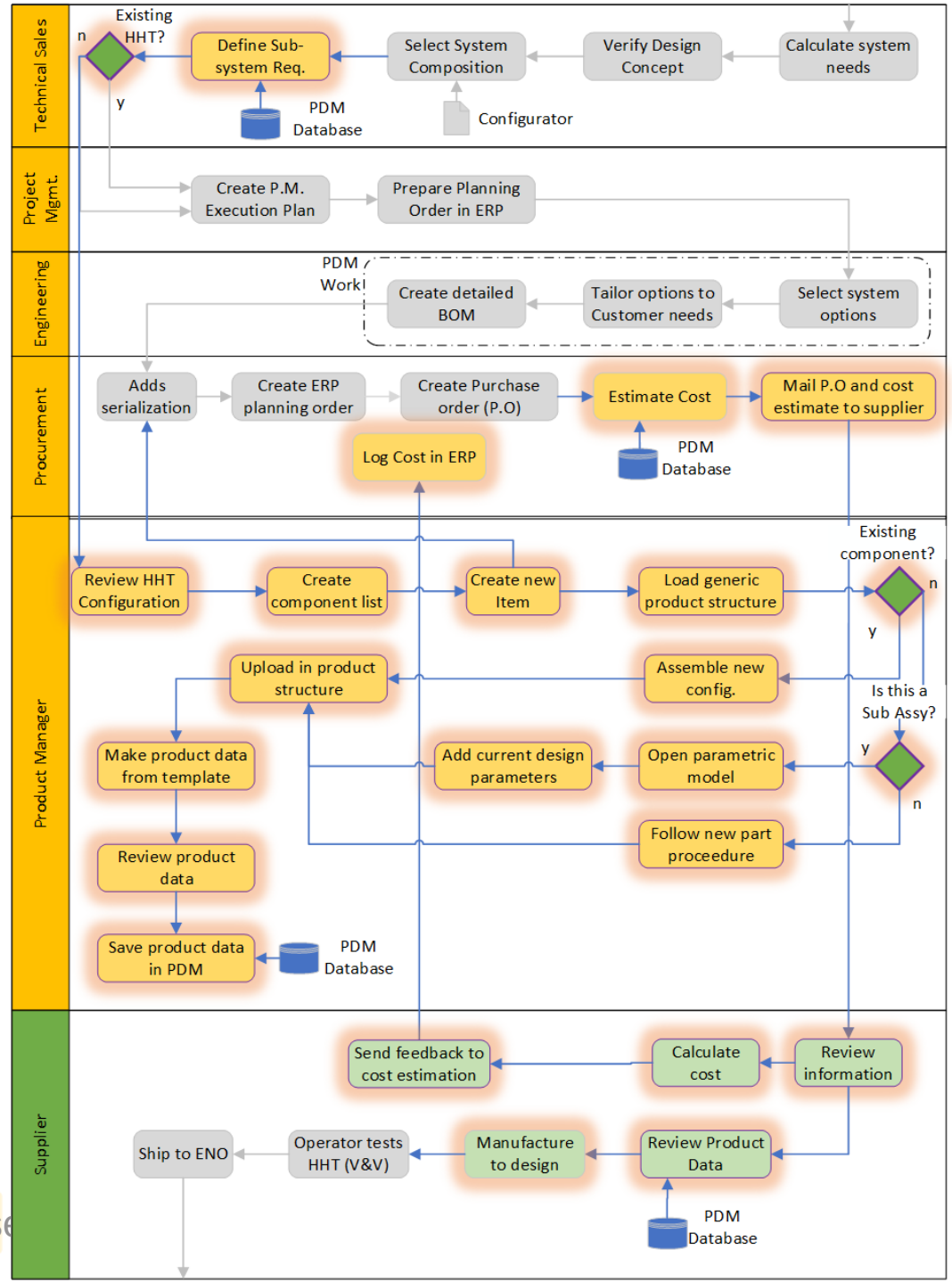
Cost prediction

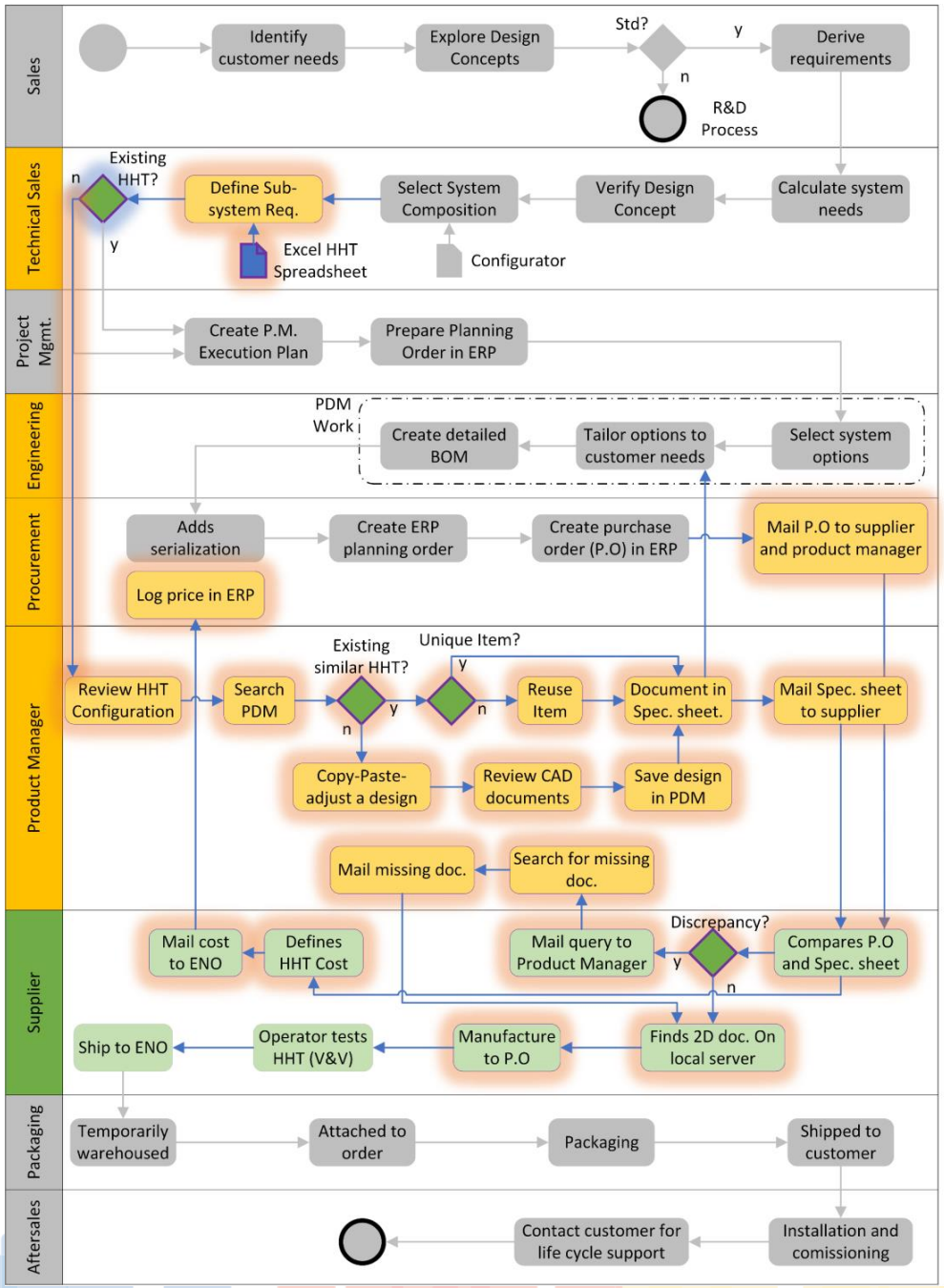
- 10 technical parameters
- 4 production parameters
- Preto chart for view the cost
- Excel sheet with PDM system

Proposed to-be




Minac
Sinac S
Sinac M
Sinac L
Sub-system boundary
INTF450
INTF680
INTF750
Final Assy
W1
W2
W2
W3
W4
f1
f2
f3
Function to Part Allocation
Basic Assembly
Mech. Parts Collected
Logistics Sub assembly
Hot Work Assy
SA1
SA2
SA3
Groups from interface mapping
Machining
P1
P2
P...


Technical Sales
Existing HHT?
n
y
Define Sub-system Req.
Select System Composition
Verify Design Concept
Calculate system needs
PDM Database
Configurator
Project Mgmt.
Create P.M. Execution Plan
Prepare Planning Order in ERP
Engineering
PDM Work
Create detailed BOM
Tailor options to Customer needs
Select system options
Procurement
Adds serialization
Create ERP planning order
Create Purchase order (P.O)
Estimate Cost
Mail P.O and cost estimate to supplier
Log Cost in ERP
PDM Database
Product Manager
Review HHT Configuration
Create component list
Create new Item
Load generic product structure
Existing component?
n
y
Upload in product structure
Assemble new config.
Is this a Sub Assy?
y
n
Make product data from template
Add current design parameters
Open parametric model
Review product data
Follow new part proceedure
Save product data in PDM
PDM Database
Supplier
Send feedback to cost estimation
Calculate cost
Review information
Ship to ENO
Operator tests HHT (V&V)
Manufacture to design
Review Product Data
PDM Database


Sales
Identify customer needs
Explore Design Concepts
Std?
y
n
Derive requirements
R&D Process
Technical Sales
Existing HHT?
n
y
Define Sub-system Req.
Select System Composition
Verify Design Concept
Calculate system needs
Excel HHT Spreadsheet
Configurator
Project Mgmt.
Create P.M. Execution Plan
Prepare Planning Order in ERP
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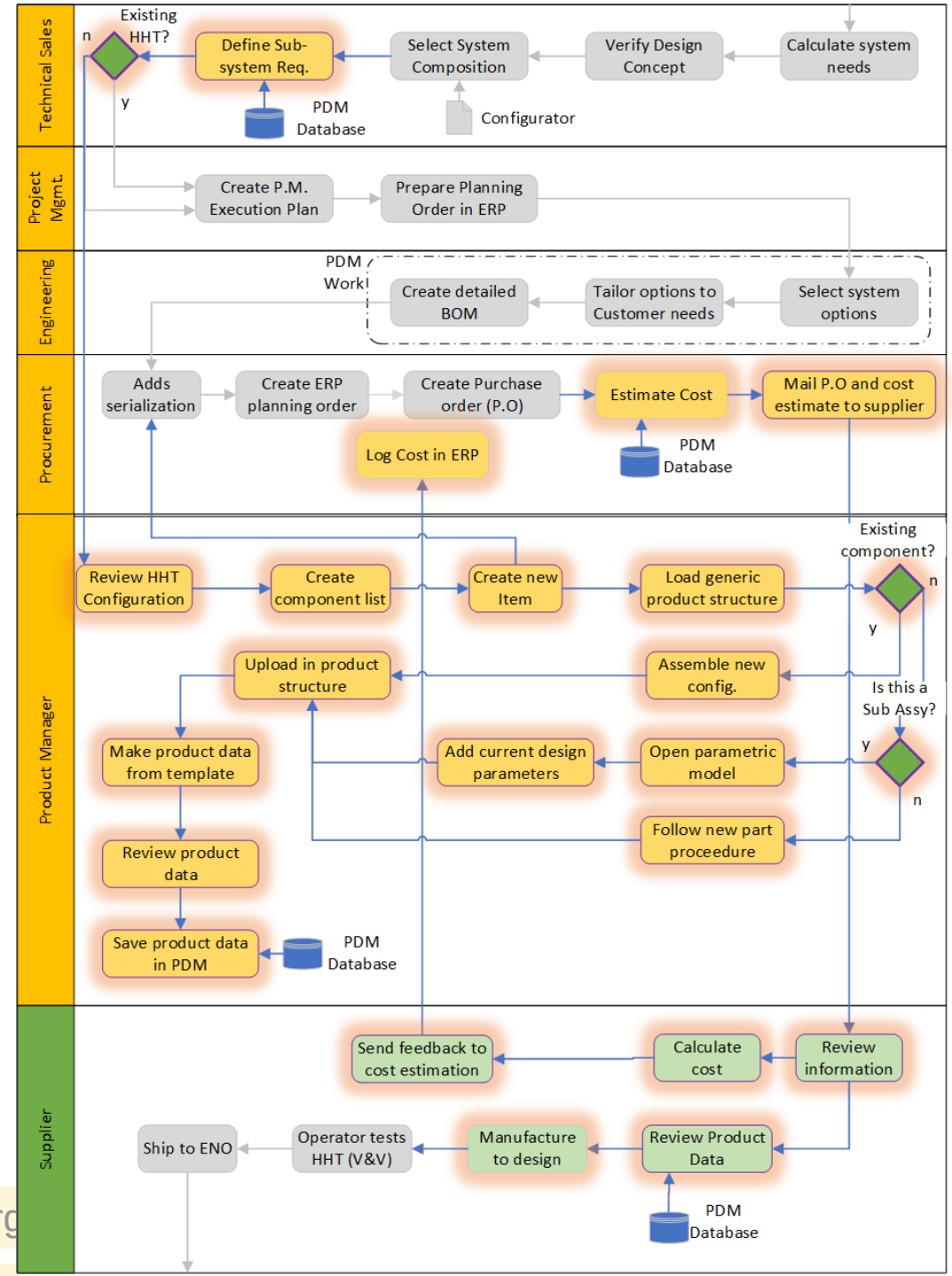
PDM Work
Create detailed BOM
Tailor options to customer needs
Select system options
Procurement
Adds serialization
Create ERP planning order
Create purchase order (P.O) in ERP
Mail P.O to supplier and product manager
Log price in ERP
Product Manager
Review HHT Configuration
Search PDM
Existing similar HHT?
Unique Item?
Reuse Item
Document in Spec. sheet.
Mail Spec. sheet to supplier
Copy-Paste-adjust a design
Review CAD documents
Save design in PDM
Mail missing doc.
Search for missing doc.
Supplier
Mail cost to ENO
Defines HHT Cost
Mail query to Product Manager
Discrepancy?
Compares P.O and Spec. sheet
Ship to ENO
Operator tests HHT (V&V)
Manufacture to P.O
Finds 2D doc. On local server
Packaging
Temporarily warehoused
Attached to order
Packaging
Shipped to customer
Aftersales
Contact customer for life cycle support
Installation and comissioning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Review Product Data
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Evaluation

What causes unpredictable product cost and uncertainty in product development for the organization?

- Affected operational efforts from product design to production, inventory, selling and service
- Lack consistency and had an inadequate quality of shared information
- Resulted in personal documents and tacit knowledge

Evaluation

What are the needs on the company for a solution that handles product variance?

- Standardize format of shared information
- Update to the standardized format with a consistent structure
- A solution that is implementable with company-specific tools
- Good quality of shared information to avoid personal documents

Evaluation

How can Systems Engineering thinking/methods help to reduce the experienced uncertainty inside the organization?

- The thinking behind our work is more important than the selected Architecting toolset
- SE facilitates holistic thinking that captured the stakeholders and their interests.
- Systems Architecting helped us concretize these needs into a solution

Evaluation

How can a product structure that follows architectural principles improve operational processes in the workflow?

- We found the architecting principles to be efficient with good quality output.
- Manufacturing and Logistics were found important to facilitate operational efforts.
- The product structure enables variability.
- The resulted workflow impact enables standardization of design processes in the workflow.

Evaluation

How can the product portfolio analysis help organizations to increase efficiency in managing product variability?

- Good fit for products with existing variability and not for new product developments.
- A potential gain in the cost-quality output.
- Evaluate the ratio before analysis and after step 1.
- Evaluate the needed techniques.

Conclusion

Company results

- 16 minutes in CAD and PDM configuration
- Cost calculator ± 10% accurate on 65% of sales volume
- Five components that made 80% of the cost
- Overall quality improvement for the company

Conclusion

Portfolio Analysis:

- Understanding decision factors helped to make the company tools
- Logistics and Manufacturing in addition to previous research
- Cost-quality ratio
- Good fit for mature products of large variations

Future research

- Confirm applicability of the analysis
- The implementation phase of similar work
- Investigating techniques

Thanks

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