

# Product Service Systems value chain configuration – a simulation based approach

by

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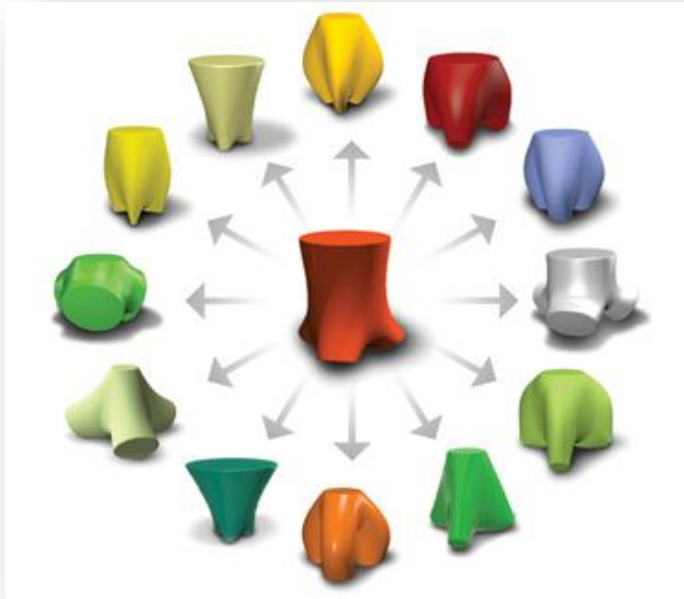
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# Introduction

## Increasing customers' individual requirements



- Increasing customer individual demands in both B2C and B2B contexts
  - Companies to seek more customer-centered business strategies
  - New forms of supplier–customer relationships

# Introduction

Decoupling environmental degradation from economic growth



# Introduction

## Transition towards Product Service Systems (PSS)

- Business is shifting from offers based on traditional physical products to Product-Service Systems (PSS)
- Transition towards PSS entails **risks** relating to the new forms of **suppliers-customer relationship, business model**, etc.
- **Decision-makers require feedback** on the viability of PSS solutions in order to make more **informed decisions** (Cavalieri and Pezzotta, 2012)



### However...

- Tools and methods to support the organizational transition, at the **operational level** are scarce (Meier et al., 2010; Boucher, 2012; Beuren et al., 2013)
- **Aim of this research**: enable well informed decisions regarding PSS value chain configuration, thus mitigating the uncertainty underpinning PSS implementation
- **Approach**: A framework relying on a combination of a **methodological** approach with modelling and **simulation**

# Outline

- **Stakeholders integration and life cycle perspective in PSS design**
- **PSS configuration and scenarios definition**
- **Methodological framework to support PSS design**
- **Simulation model for PSS assessment**
- **Case study in the sludge treatment sector**
- **Conclusions and research perspectives**

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# Product-Service Systems design (1/2)

## Life cycle perspective and stakeholders integration

- Industrial Product-Service Systems emerge as a promising business model for **manufacturing** companies
- A PSS “... is characterized by the integrated and mutually determined planning, development, provision and use of product and service shares...” (Meier et al., 2010)
  - **Joint development of products and services**
- Purchasing cost accounts for no more than 50% of the whole PSS life-cycle costs (Meier et al., 2010, Mannweiler et al., 2010)
  - **A life cycle perspective**
- Need for **operational solutions** (Davies, 2004; Aurich et al., 2010; Baines et al., 2009; Mannweiler et al., 2010; Beuren et al., 2013)
- Need to develop tools that consider **service operation** (i.e. service production) (Meier et al., 2010, Mannweiler et al., 2010)
  - **Operational tools** to fill the gap left by the focus on conceptual level
- PSSs draw upon a lot of internal and external resources (Meier et al., 2010; Kimita and Shimomura, 2014, etc.)
  - **A PSS network perspective**

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# Product-Service Systems design (2/2)

## PSS scenarios and configuration



### Challenge for the PSS assessment in *priori*...

- Heterogonous data, e.g. activities, services, products, etc.
  - Various stakeholders, e.g. product provider, service provider, etc.
- Scenarios allows the recognition of potential threats **prior to implementation** of the PSS solution

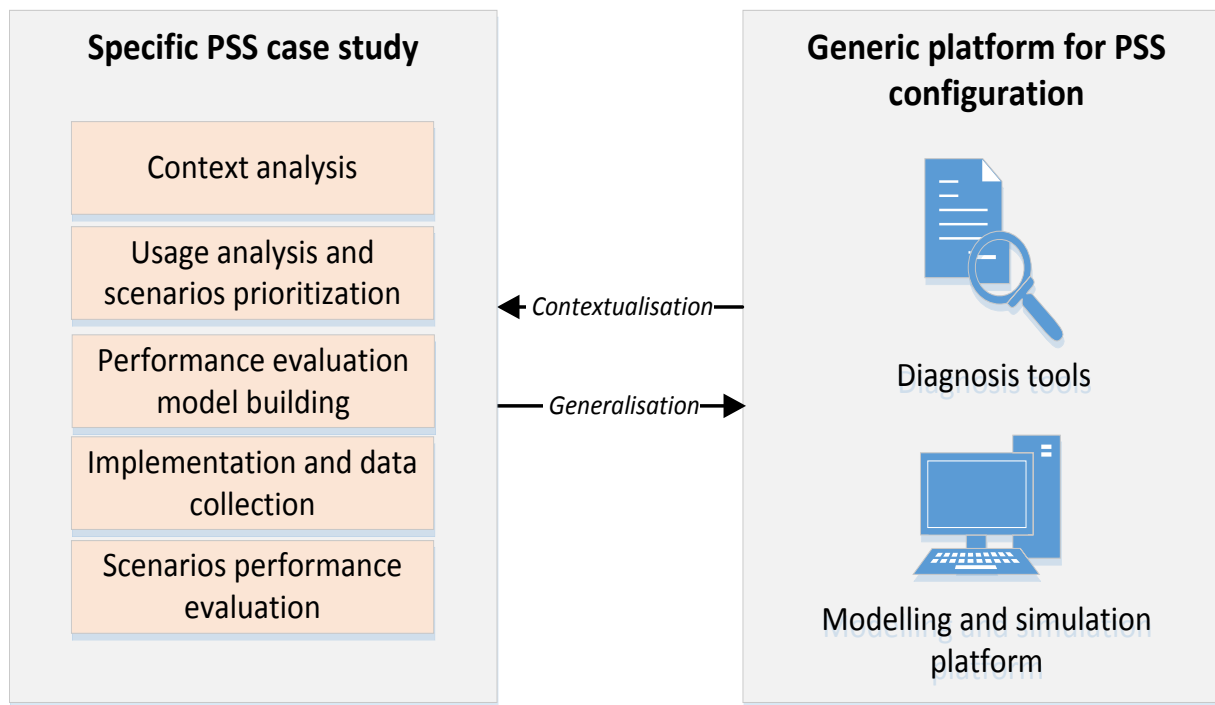
- Scenario: combination of a given PSS configuration, activities and PSS actors having specific roles with the value chain
  - Need to define the different **performers of value chain activities**
- Scenarios are an appropriate tool for conceptualizing the potential **value-chain configurations**
- A **multi-actor perspective** is required to reflect actors' standpoints

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## Focus and steps of the methodology

- *Aim:* support the rapid development of **Decision Support Systems (DSS)** for **PSS value-chain configuration**
- *Focus:* Small and Medium sized Enterprises (SMEs), in particular, a PSS value chain that is configured around a focal company leading the PSS

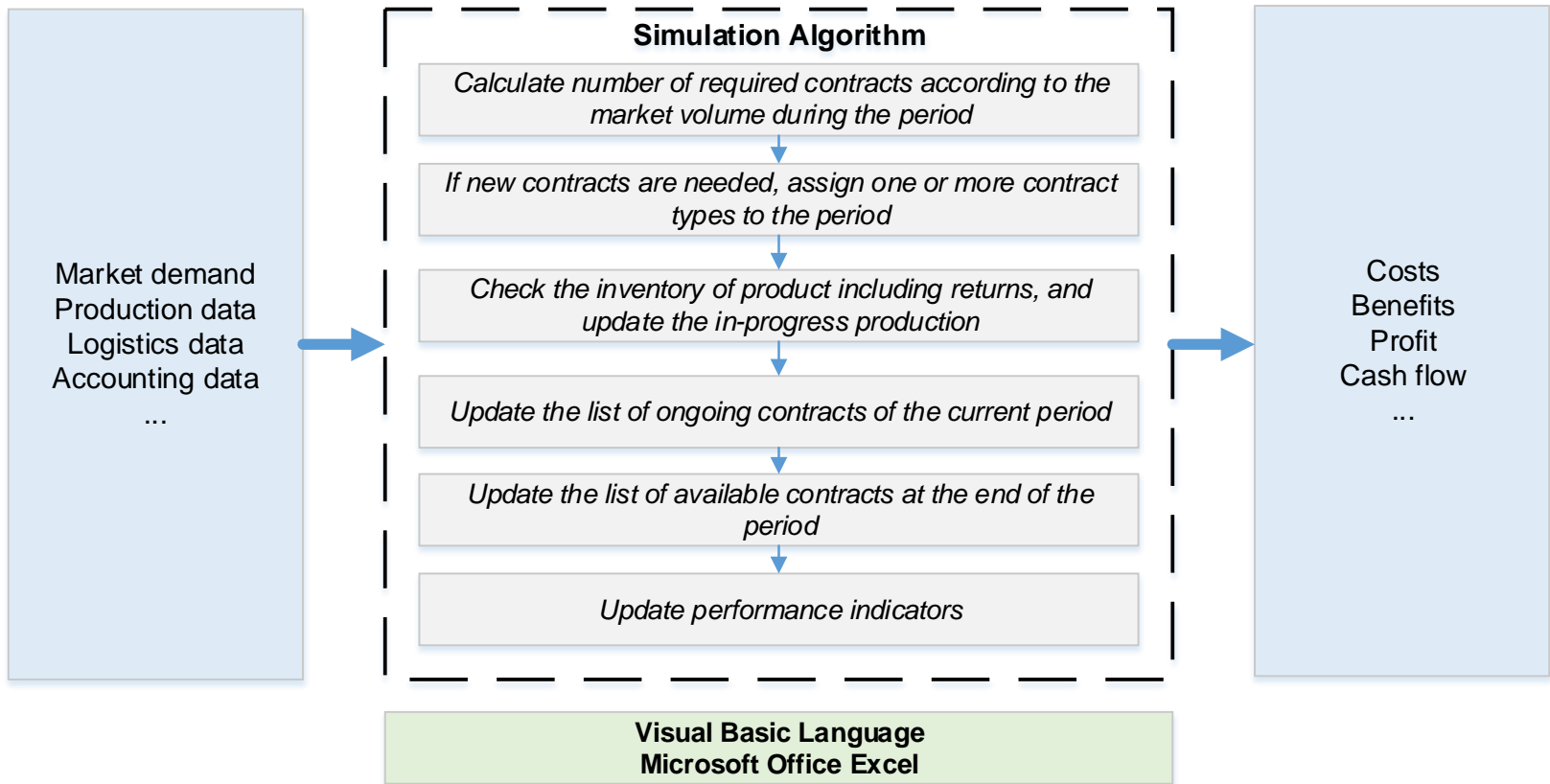


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## Simulation model for PSS assessment

- **Inform decision-makers** of the potential organizational and economic spinoffs
  - Mitigating PSS implementation related **risks**
- Deterministic continuous simulation model

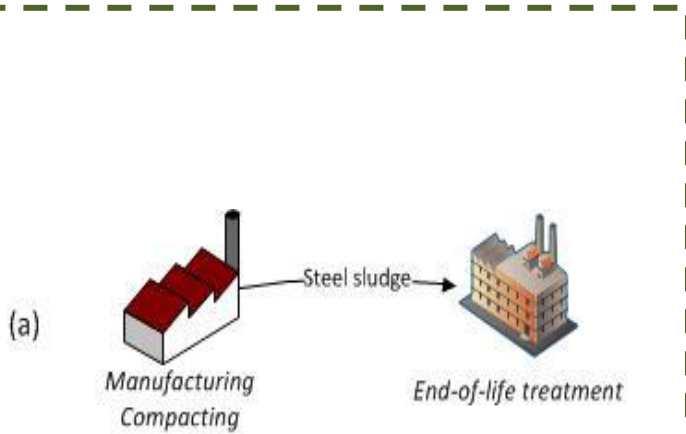


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# Case study in the sludge treatment sector (1/9)

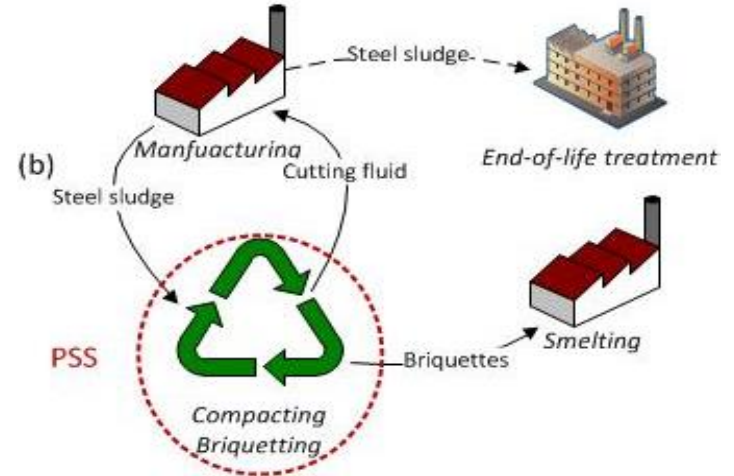
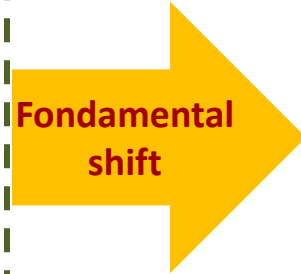
## Context of the case study



→ get rid of the sludge!

### Actors:

- Manufacturers producing sludge
- End-of-Life treatment company



→ make money out of the sludge and save natural resources!

### Actors:

- Manufacturers producing sludge (**potential customers of the envisioned PSS solution**)

### And...

- **Equipment provider** (i.e. briquette-making equipment)
- Smelters using electric arc furnaces for melting steel scrap and other metals (**potential customers for the produced briquettes**)

# Case study in the sludge treatment sector (2/9)

## Organizational scenarios identification

### Specific PSS case study

Context analysis

Usage analysis and scenarios prioritization

Performance evaluation model building

Implementation and data collection

Scenarios performance evaluation

- Semi-structured interviews with the PSS actors
- 18 organisational scenarios
- Selection according to i) compliance to regulations, ii) added value for the value-chain actors, including final customer.
- S1: equipment provider sells the equipment to the manufacturers (who compact and sell briquettes to smelters)
- S2: equipment provider rents the equipment to the manufacturers (who compact and sell briquettes to smelters)
- S3 equipment provider sells the equipment to an intermediary (who compacts and sells briquettes to smelters)
- S4: equipment provider offers the compacting service (mobile equipment)



# Case study in the sludge treatment sector (3/9)

## Performance evaluation model building

### Specific PSS case study

Context analysis

Usage analysis and scenarios prioritization

Performance evaluation model building

Implementation and data collection

Scenarios performance evaluation

- Cost (services, production, logistics, etc)
- Revenues (services, equipment sales, briquettes sales, cutting fluid economies, waste treatment economies, etc.)

• And... Profit

→ Quite traditional indicators...

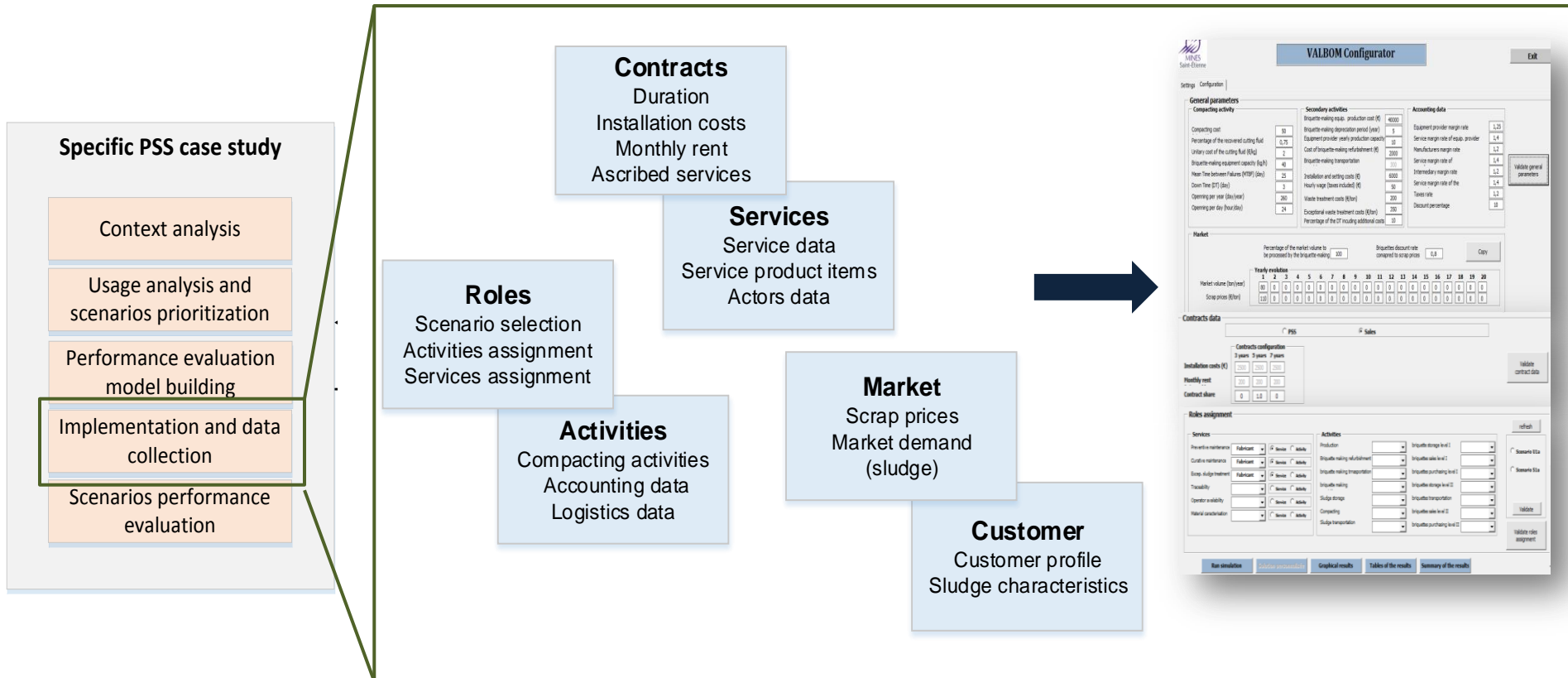
However...

→ This all the partners needed... so far

# Case study in the sludge treatment sector (4/9)

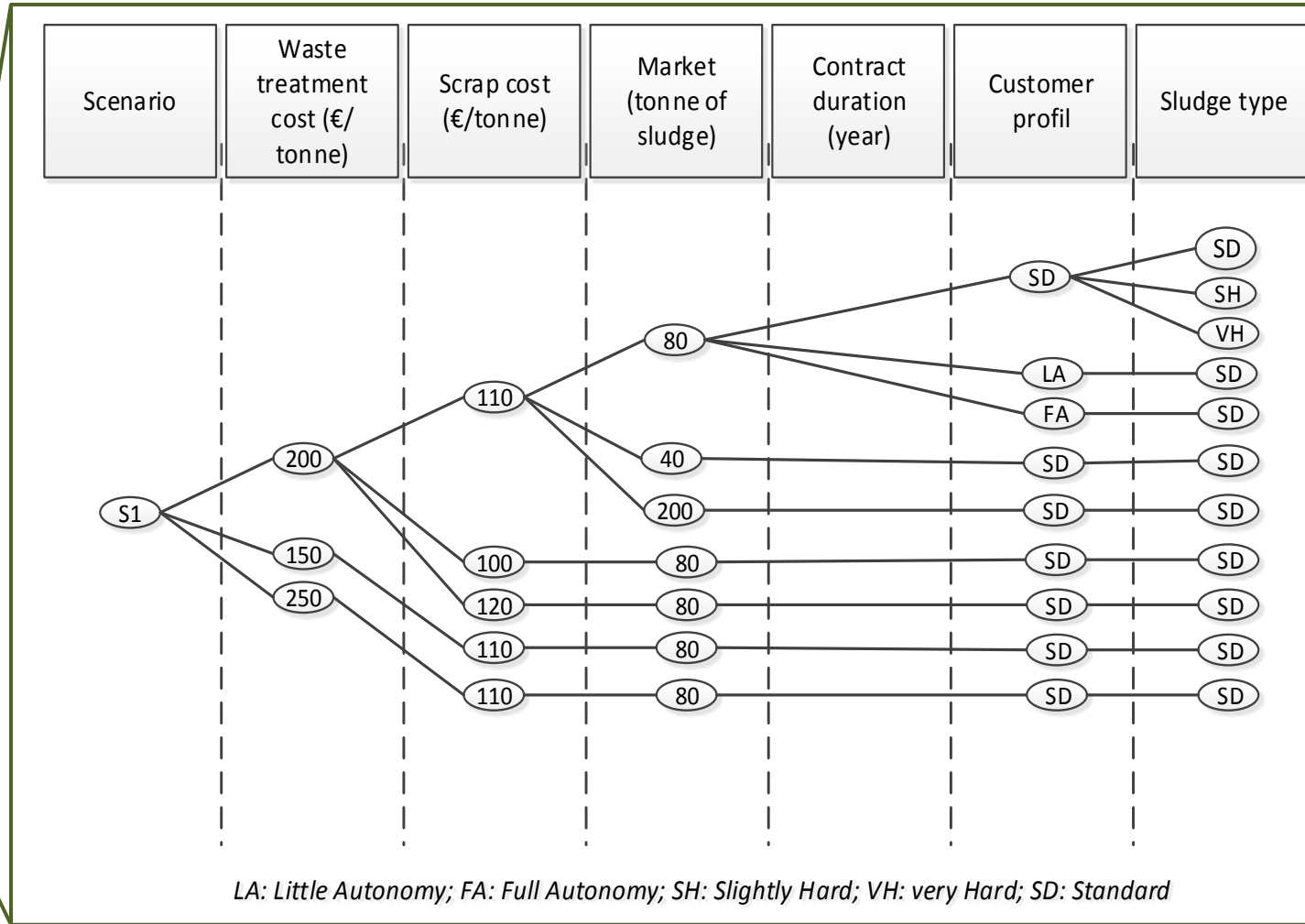
## Data Collection

- The collection process is based on **questionnaires** and on **face-to-face meetings**  
 → challenging because of the **multi-actor perspective** and the **heterogeneity of the data**



# Case study in the sludge treatment sector (5/9)

## Experimentation plan for S1-S3



### Specific PSS case study

Context analysis

Usage analysis and scenarios prioritization

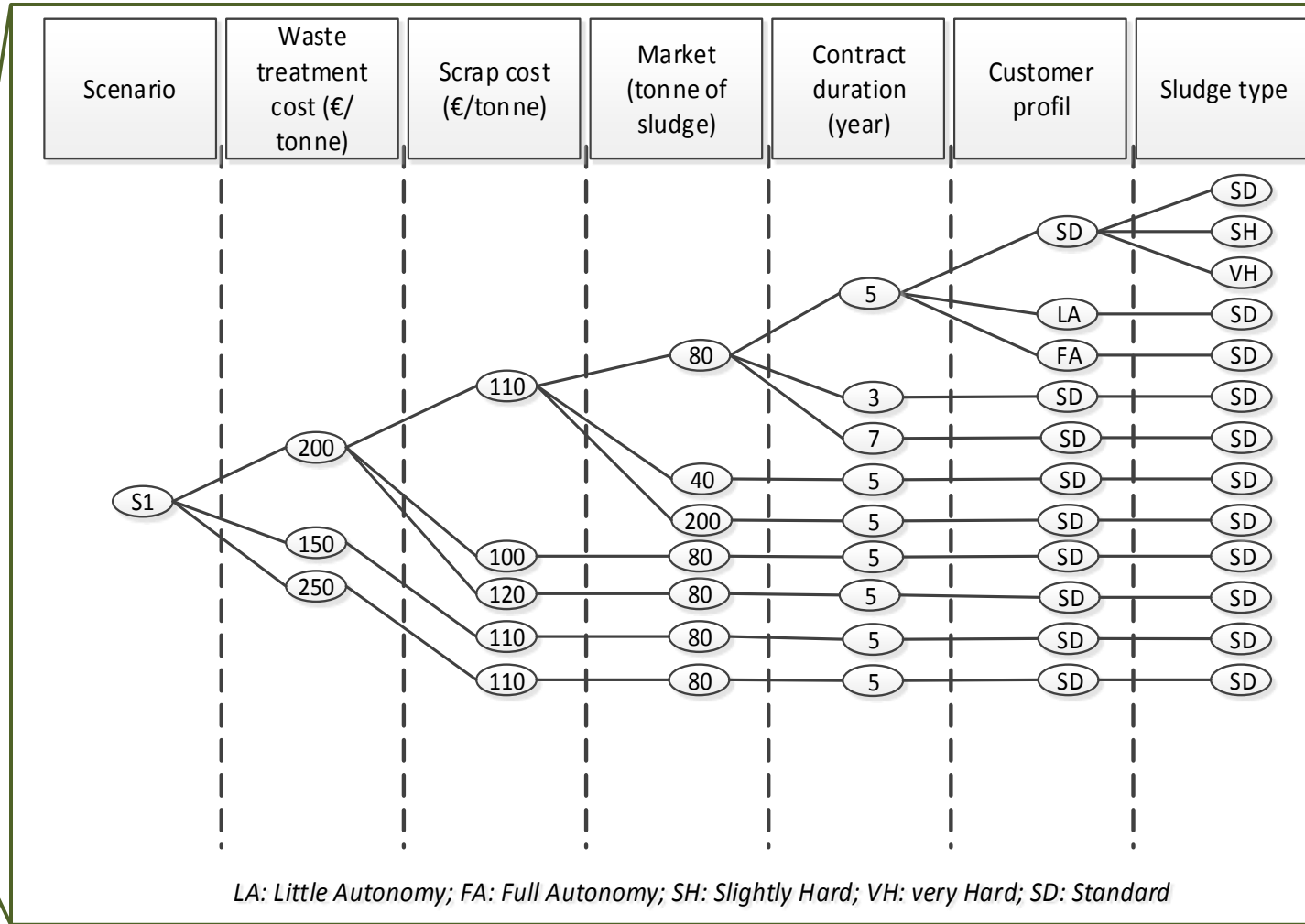
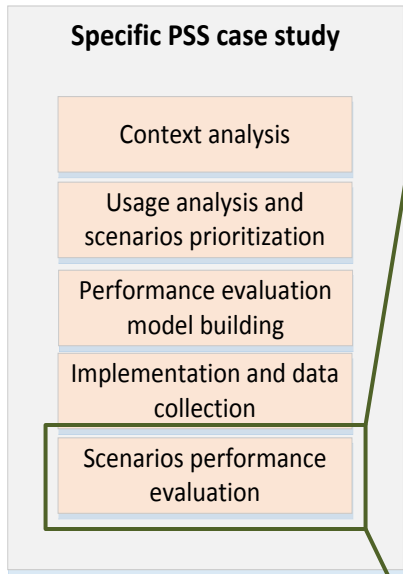
Performance evaluation model building

Implementation and data collection

Scenarios performance evaluation

# Case study in the sludge treatment sector (6/9)

## Experimentation plan for S2-S4



# Case study in the sludge treatment sector (7/9)

## Regression tree for Equipment Provider profit

### Specific PSS case study

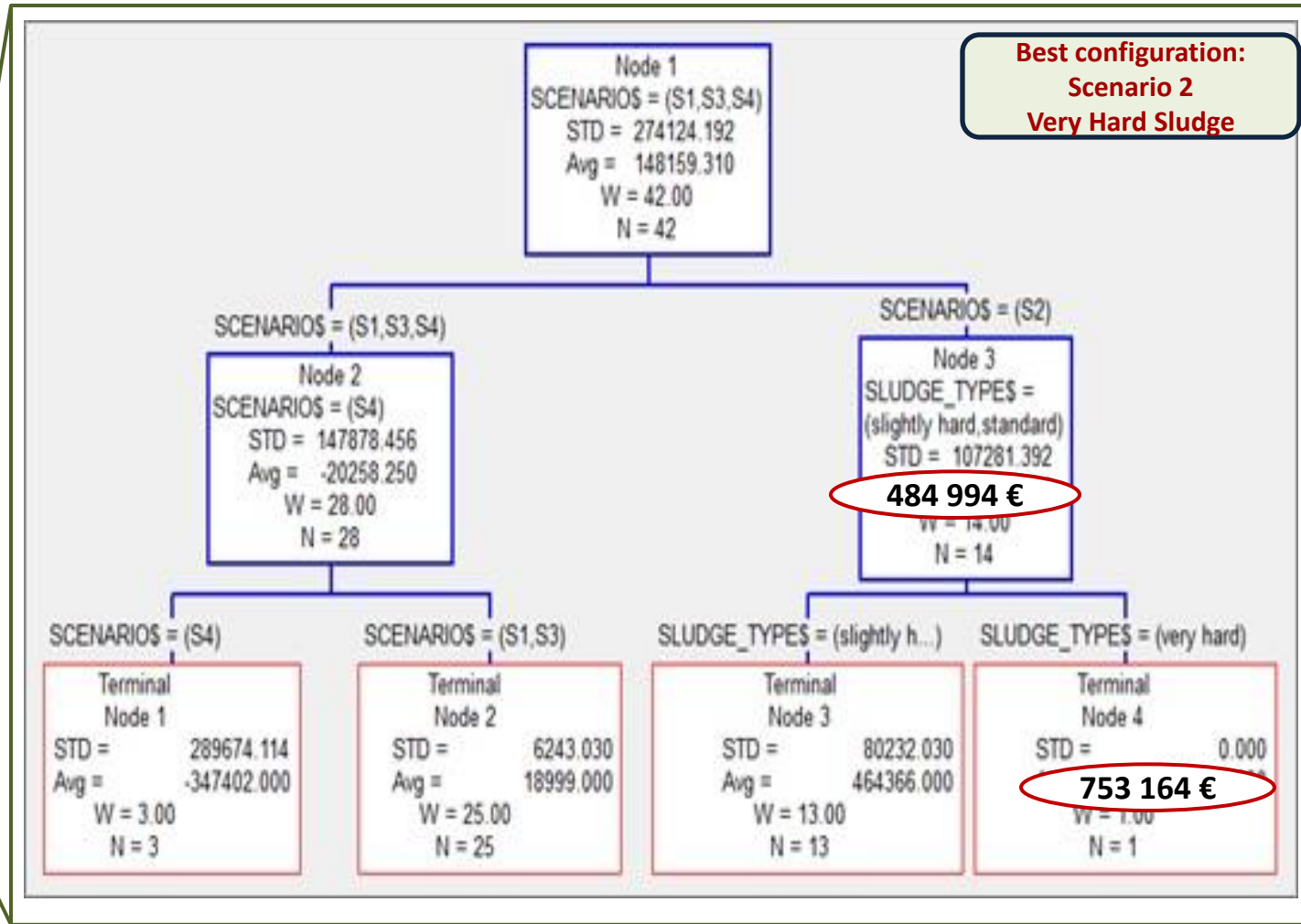
Context analysis

Usage analysis and scenarios prioritization

Performance evaluation model building

Implementation and data collection

Scenarios performance evaluation



# Case study in the sludge treatment sector (8/9)

## Regression tree for manufacturers profit

### Specific PSS case study

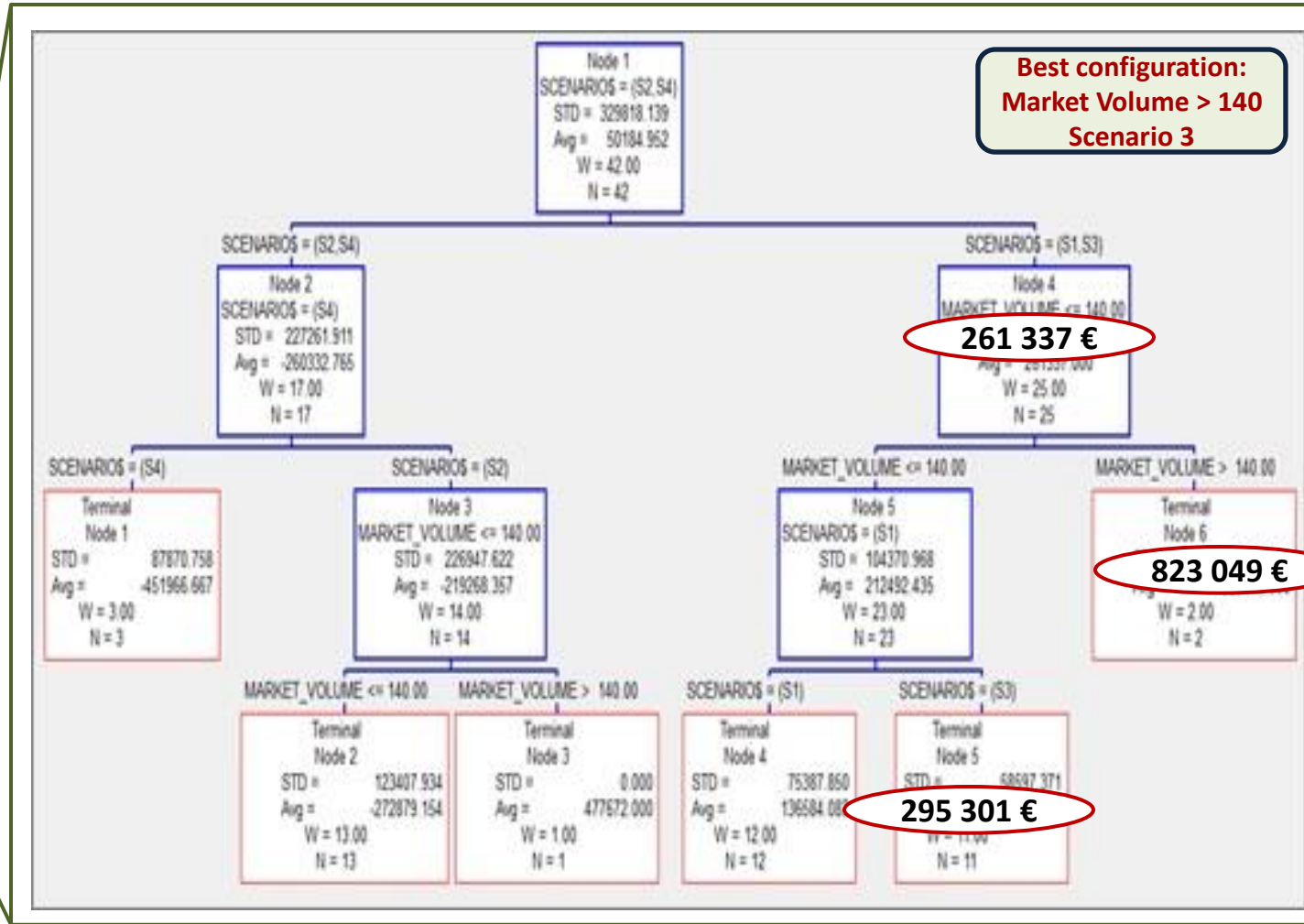
Context analysis

Usage analysis and scenarios prioritization

Performance evaluation model building

Implementation and data collection

Scenarios performance evaluation



# Case study in the sludge treatment sector (9/9)

## Insights from the case study

- There exist **several drivers** for the actors' performances, such as the **market volume**, and **roles** assigned to actors within the PSS value chain
  - **Scenarios** are the most **important drivers** of performance. Therefore, the **configuration** of the value chain, which defines the roles assigned to each actor, has a notable **leverage effect**.
  - Scenario 4 is unprofitable for both equipment provider and manufacturers
  - Scenario 2 is the most interesting one for the equipment provider, in terms of profitability, but it is unprofitable for the manufacturers
  - Scenarios 1 and 3 are profitable for both equipment provider and manufacturers
- **Trade-offs** should be made to cope with both equipment provider and manufacturers' requirements
- A reasonable foundation for **further investigation** regarding the **impact of other parameters**, e.g. geographical dispersion of the actors, demand thresholds, etc.

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# Conclusion

## Summary and research avenues

- The framework provides a **methodological guidance**
- Assessment of PSS value chains configurations using **Simulation-based DSS**
- The case study provides evidence on the framework **applicability** and added value

### However, it leaves a lot to be desired...

- Assessment according to the three PSS feasibility pillars; **business viability, customer satisfaction** and **environmental soundness** (Mont, 2002; Yoon et al., 2012)
- Evaluate whether the PSS solution meets **customers' requirements** (Geng et al., 2011; Mert et al., 2014; Shimomura et al., 2015)
- **Quantification of uncertainty** to strengthen the decision-aid provided to PSS actors
- Operational level involving **production and delivery management** (the territorial perspective)

### And...

- Transferring concepts such as **commonality** and product **modularity** to the PSS
- leverage PSS potential for companies, customer and environment

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**Thank you!**