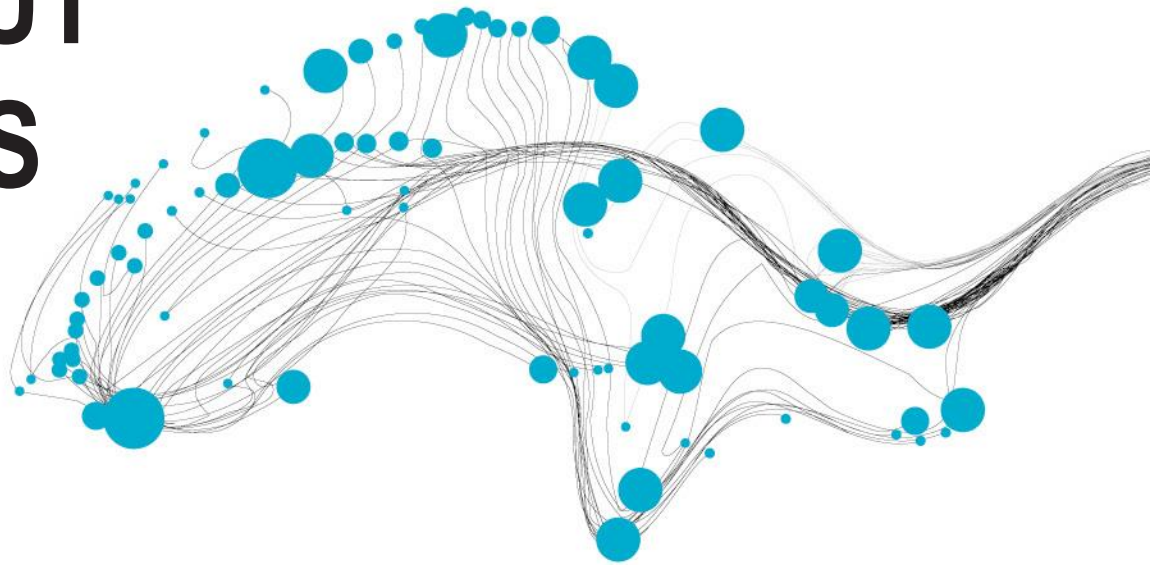
Department of Design, Production & Management
Asset Management and Maintenance Engineering Chair

BUSINESS CASES AS INPUT TO APPRAISAL DECISIONS

FACILITATING BUSINESS CASE MODELING FOR NATIONAL-LEVEL DECISION-MAKING ON AUTONOMOUS DRIVING TECHNOLOGIES IN THE RAILWAY SECTOR



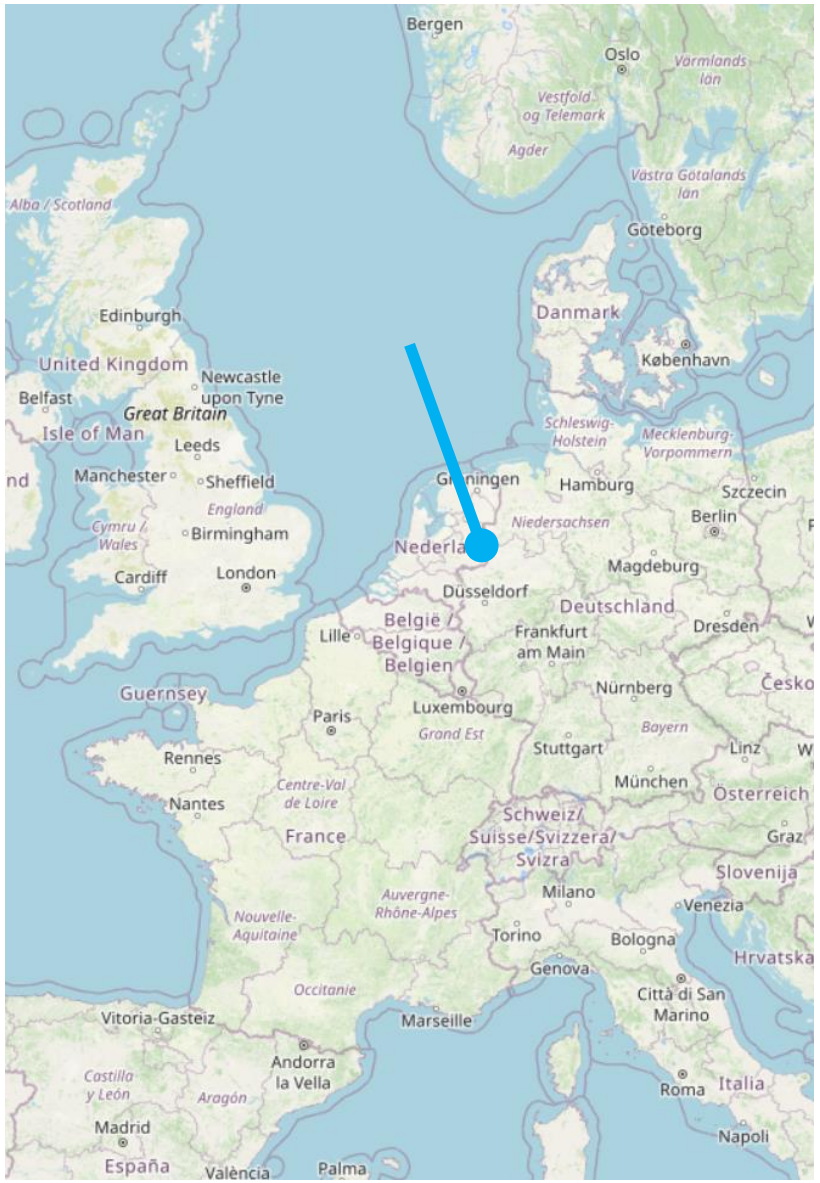
Prof. Dr. Jan Braaksma (a.j.j.braaksma@utwente.nl)
Dr. Ir. Giacomo Barbieri (g.barbieri@utwente.nl)

20/09/2024

R2DATO UNIVERSITY OF TWENTE.

UNIVERSITY OF TWENTE IN THE NETHERLANDS

- Technical University in Enschede, the Netherlands
- Largest and first “Campus style” University in the country
- Focus on Technology, Engineering, People, and Society
- ± 12.000 students and ± 3.150 staff
- Faculties of:
  - **Engineering Technology (ET)**
  - Behavioral, Management & Social Sciences (BMS)
  - Others: EEMCS, TNW, ITC.



More info

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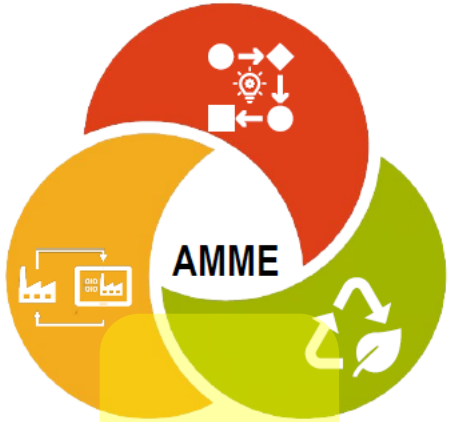
ASSET MANAGEMENT AND MAINTENANCE ENGINEERING

Maintenance Engineering & Management

Methods and tools for managing assets, maintenance concept development, FMEA & RCM.



Smart maintenance

Organizational factors related to new maintenance technology, Predictive maintenance, Systems integration, Digitalisation, AR/VR, Data driven decision-making,

Sustainable Asset Management

Strategic decision-making, Life Cycle Planning, Life Cycle Value, Alignment of goals related to circularity, climate action, energy transition.

Decision-making for high capital investments in technological solutions

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APPLICATION AREAS / COLLABORATION PARTNERS

Process industry (e.g. Nobian, Shell, Sabic, Huntsman)

Public Asset Owners (e.g. Ministry of defense, RWS)

AMME

Railway sector (trains and civil infrastructure)

Energy sector (energy distribution)

Cranfield University

NTNU

WORLD CLASS MAINTENANCE

ProRail

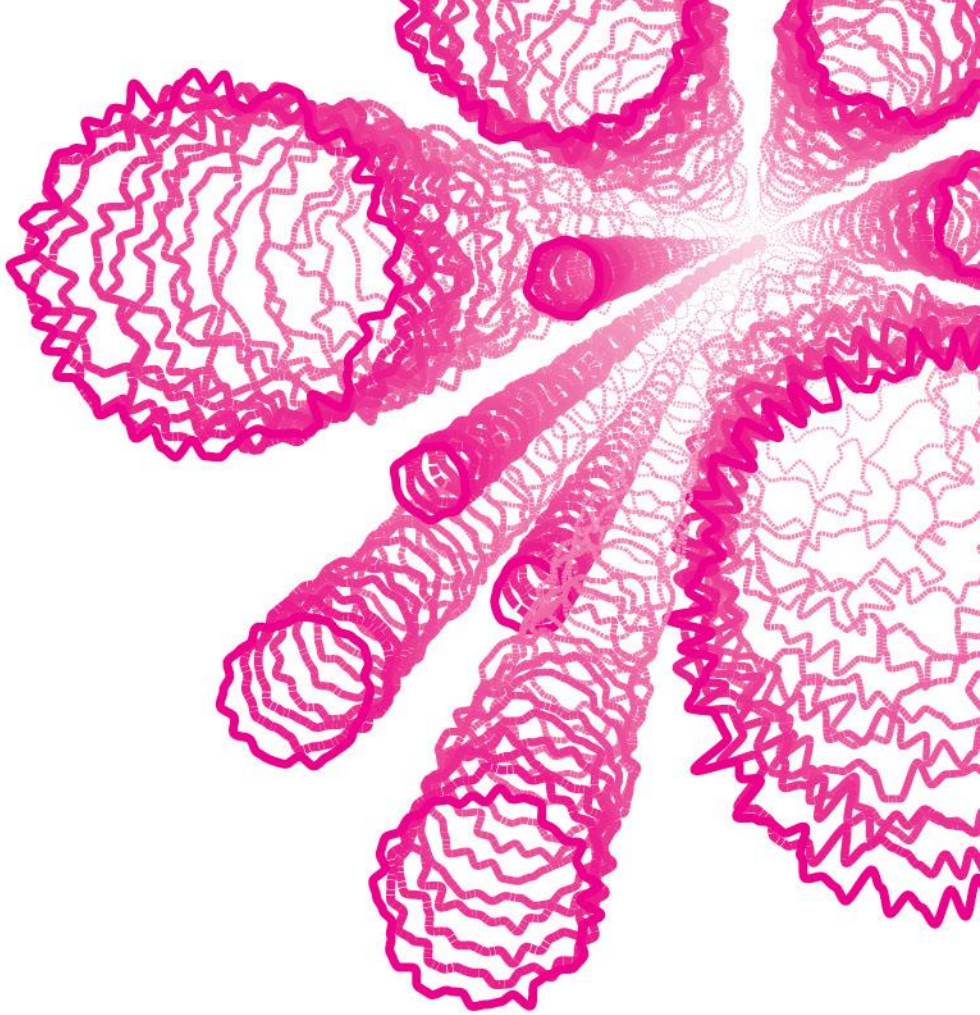
Europe's Rail

Newcastle University

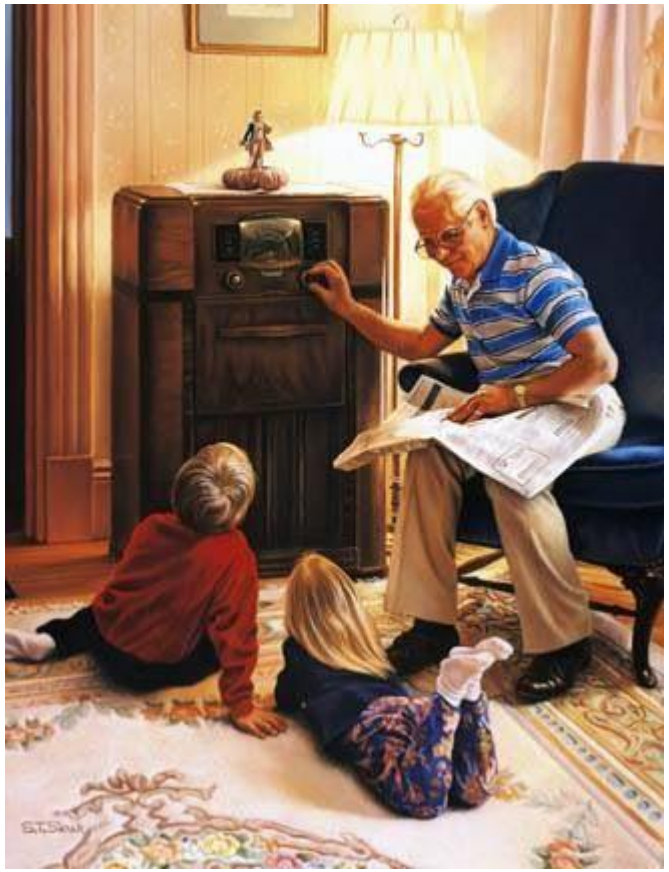
CONTENT

- Decision making in technological projects: The Smart Home Upgrade
- Participatory Business Cases
- Business Case for Automatic Train Operations
- Conclusions

THE SMART HOME UPGRADE



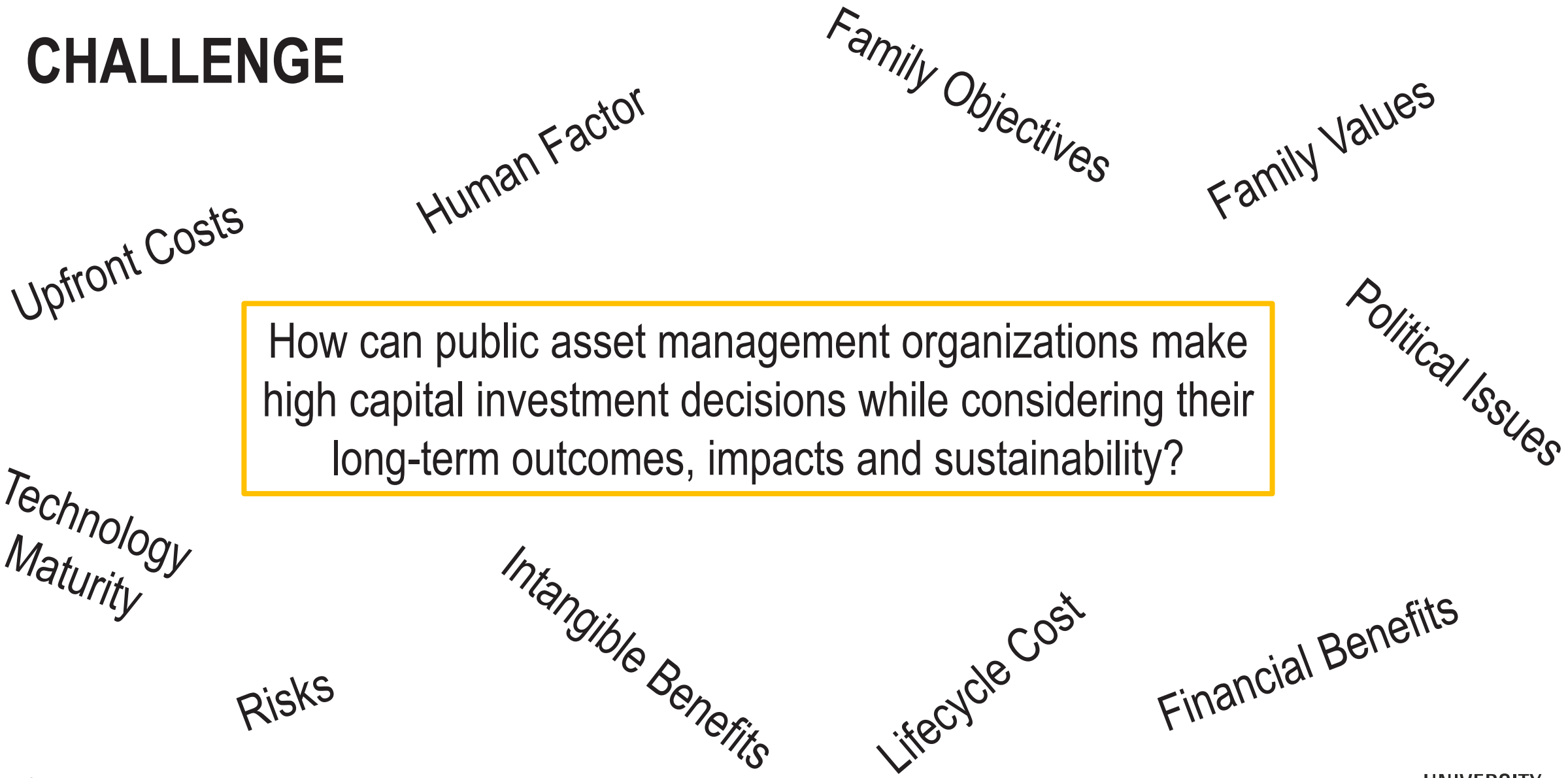
CONTEXT



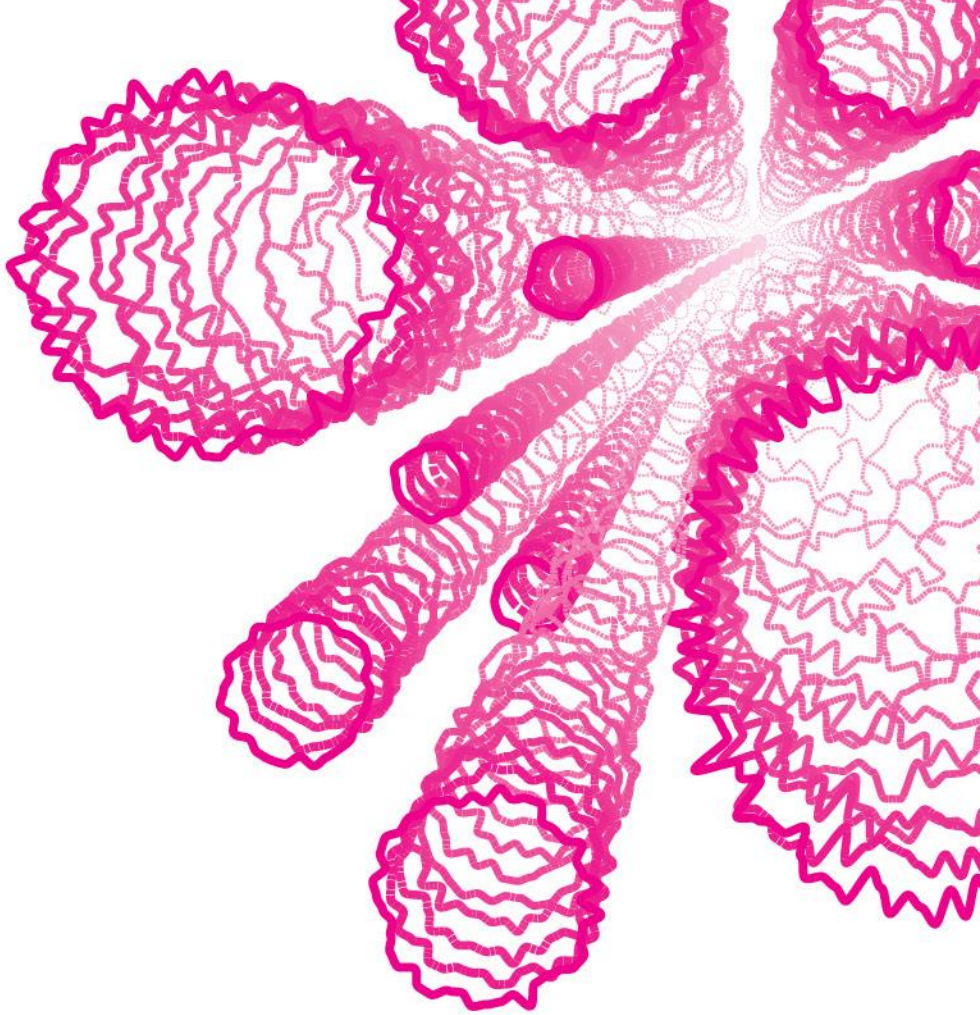
ALTERNATIVES

- Option 1: Continue with the current setup
- Option 2: Upgrade only the most critical systems
- Option 3: Full Smart Home upgrade

CHALLENGE

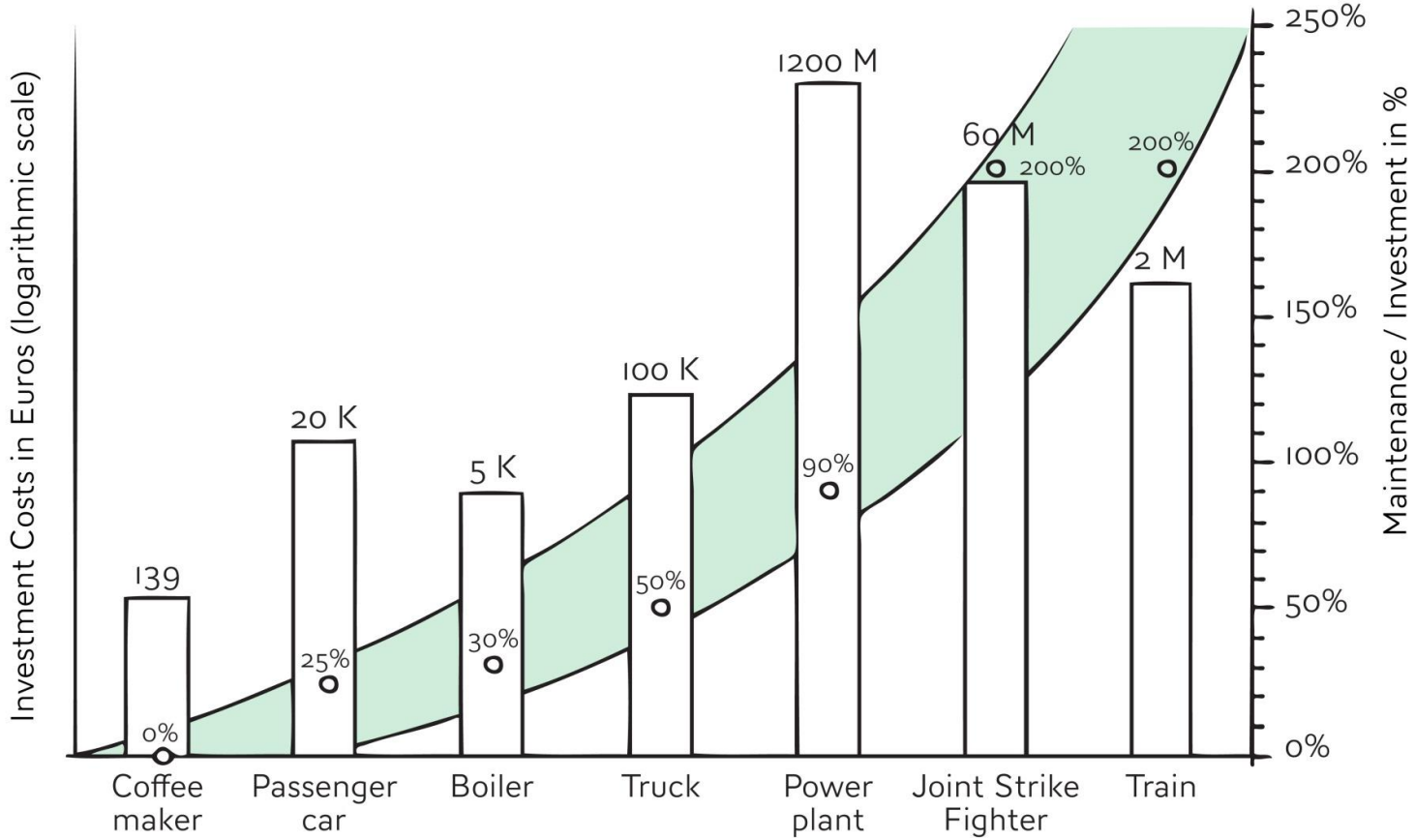

Family Objectives
Human Factor
Family Values
Upfront Costs
Political Issues
How can public asset management organizations make high capital investment decisions while considering their long-term outcomes, impacts and sustainability?
Technology Maturity
Intangible Benefits
Lifecycle Cost
Financial Benefits
Risks

PARTICIPATORY BUSINESS CASES



MAINTENANCE TENDS TO BE HIGHER THAN THE INVESTMENT COSTS

…when capital investments and projects are considered in isolation, without accounting for the entire lifecycle of infrastructure and engineering assets…



ASSET MANAGEMENT

Asset Management is the ***optimal lifecycle management*** *of physical assets to* ***sustainably*** *achieve the stated* ***business objectives***

In project governance, we contribute to estimate and plan the whole lifecycle cost and value and to reply fundamental questions such as:

1. Do we need to renew or construct an asset / infrastructure?
2. How are we going to maintain it?
3. How are we going to operate it?
4. What spares will we store and where?
5. When will we have a refurbishment?
6. When and how we will dispose it?

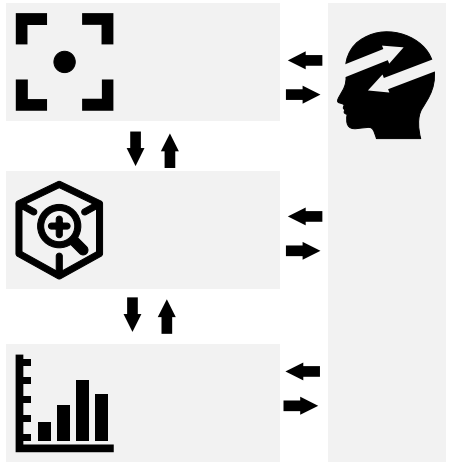
BUILDING BUSINESS CASES / COST BENEFIT ANALYSIS FOR STRATEGIC ASSET DECISIONS

Qualitative and non-financial evidence

Quantitative and financial evidence

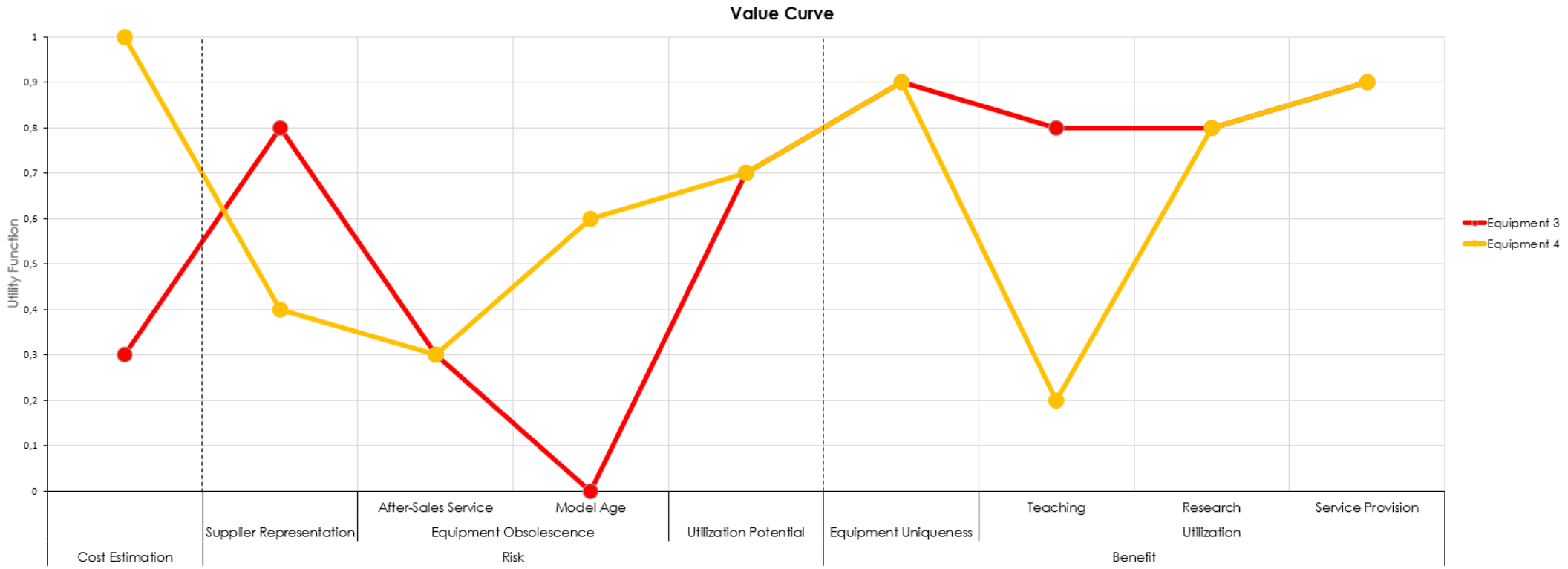
QUANTITATIVE BUSINESS CASES

LCV is a methodology that employs a modular calculation approach to assess the life cycle value of assets, focusing on the most relevant costs and benefits from the organization's perspective



Haanstra W. et al (2021), Life Cycle Valuation: Designing a modular methodology for managing the costs and benefits of physical assets over their life cycle, Utwente, Phd thesis

DATA AVAILABILITY AND FIT FOR PURPOSE SEMI-QUANTITATIVE BUSINESS CASES



15 **Barbieri G.**, Vega A. S., Gutierrez J., Laserna J., Mateus L.M. (2024, under review). Strategic Capital Investments in Asset Management: a Value-based Approach. Journal of Quality in Maintenance Engineering

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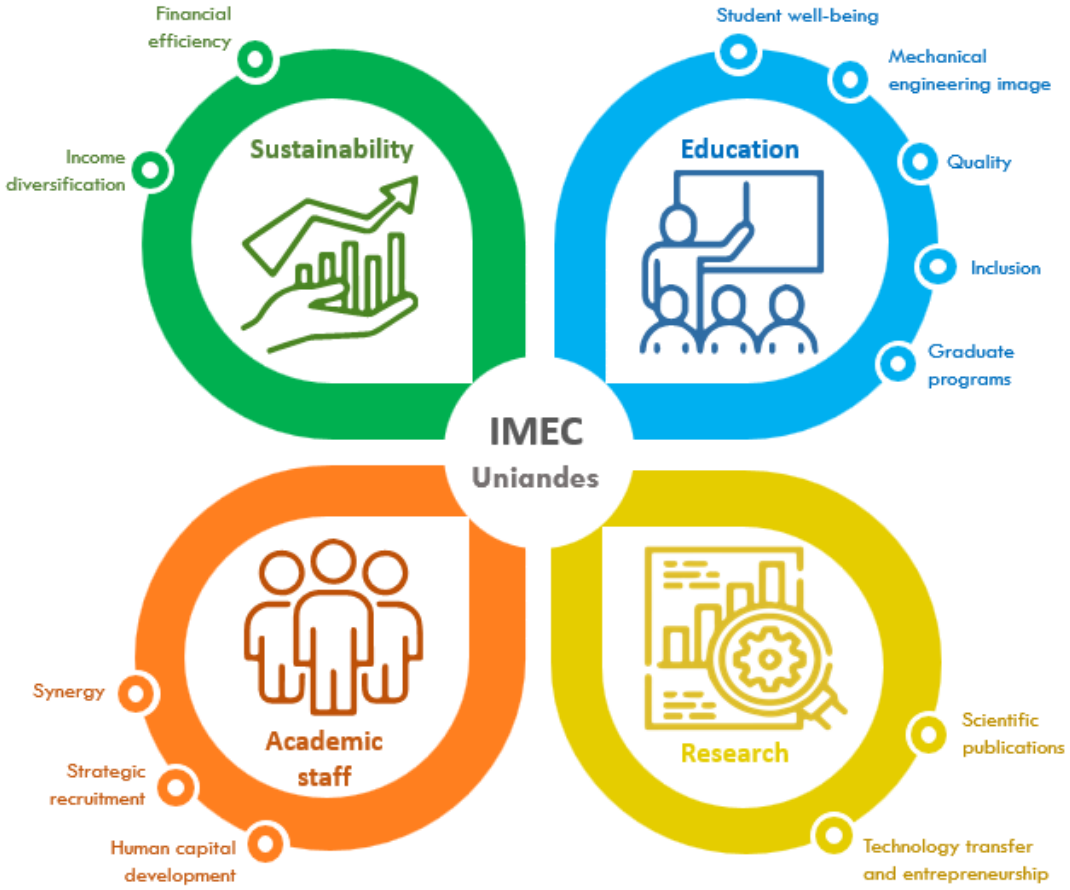
VALUE-BASED DECISION-MAKING: A STEPWISE APPROACH



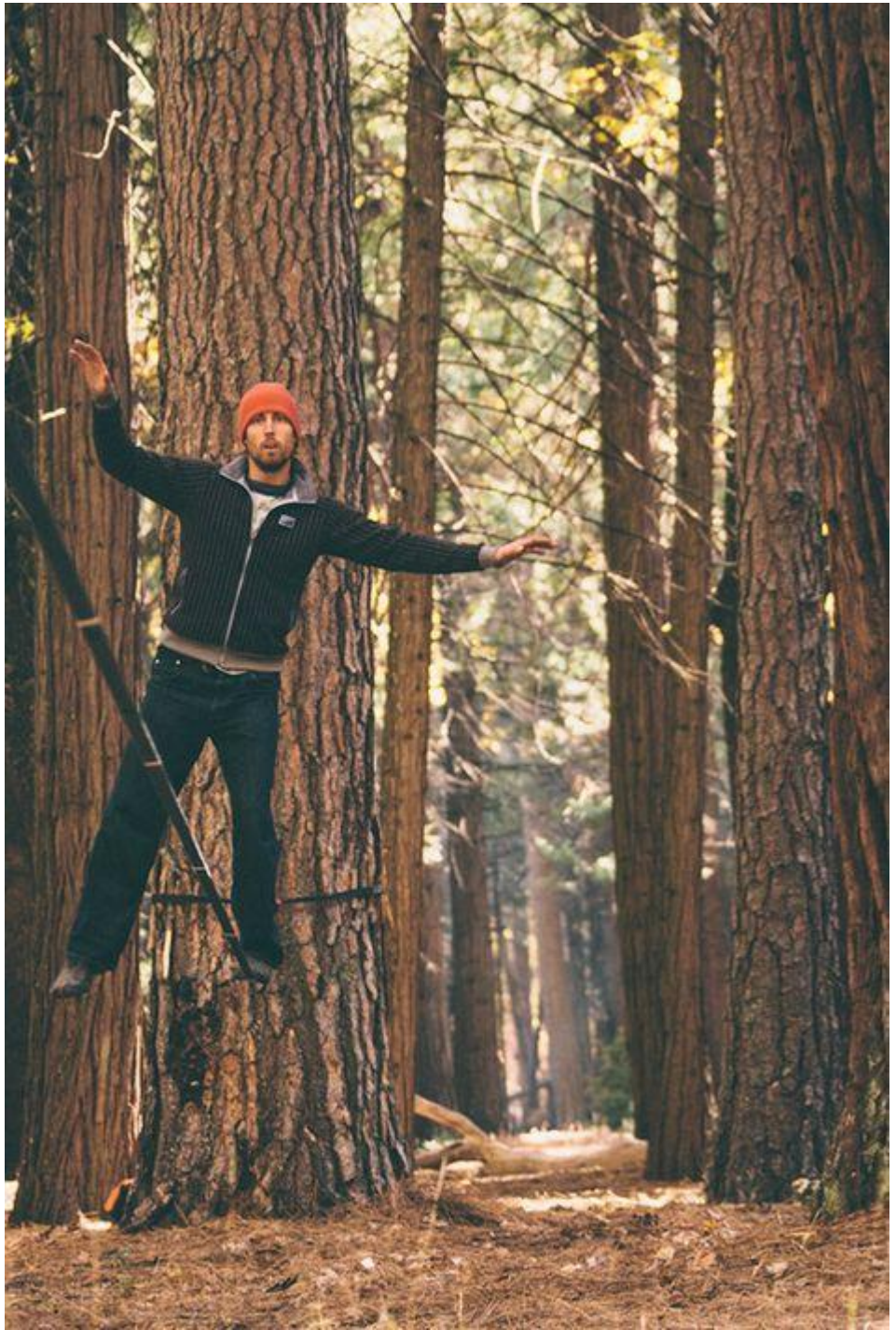
Starting with a semi-quantitative approach can be especially beneficial when various dimensions of value, beyond just financial aspects, must be considered, particularly in complex projects involving high capital investments

Barbieri, G., Benavides, A. M., Esteves, L. A., Olaya, C., & Zapata, F. (2024). Organizational Value Framework for Asset Management Decision-Making. IFAC-PapersOnLine, 58(8), 395-400.

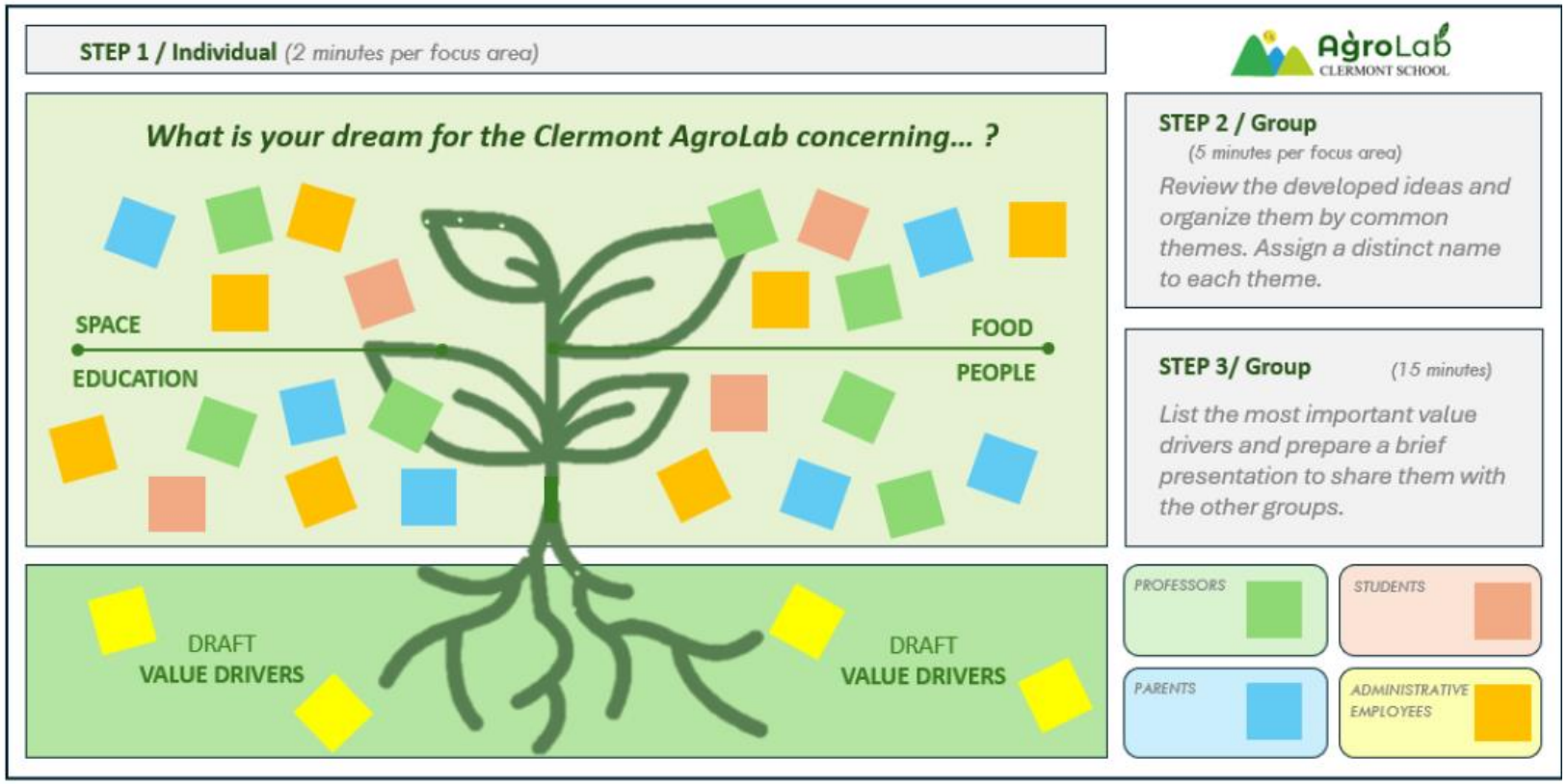
PARTICIPATIVE EVALUATION

Appraising high capital investments is inherently a political process, as it involves balancing the diverse interests of numerous stakeholders.

A participatory approach can be adopted to ensure inputs from and alignment among all parties and acceptance of modelling outcomes



PARTICIPATORY APPROACHES – BRAINSTORMING (1)



18 **Barbieri G.**, Zapata, F. and Roa De la Torre, J. D. (Under review, 2024) Asset Management and Social Innovation to Define Educational Facilities in the Era of Industry 5.0. IEEE Access.

PARTICIPATORY APPROACHES – EXPERT BASED: DELPHI (2)

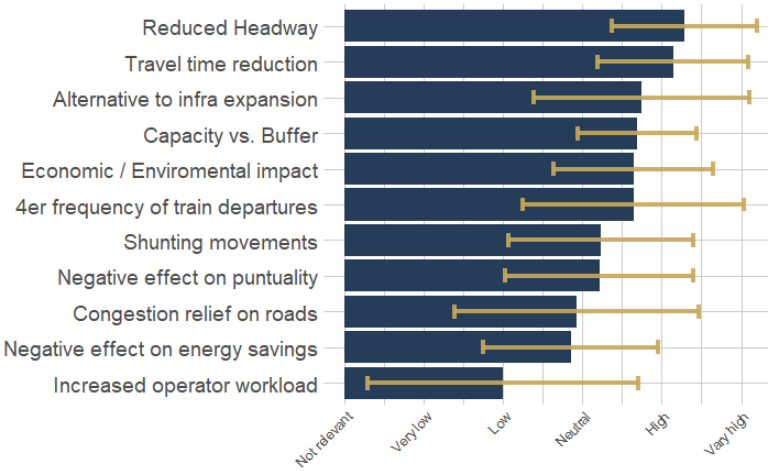
Common impacts

- Reduced Headway
- Travel time reduction
- Capacity vs. Buffer
- Alternative to infra expansion
- Negative effect on punctuality
- Negative effect on energy savings
- Increased operator workload
- Congestion relief on roads
- Economic / Environmental impact
- Higher frequency of train departures
- Shunting movements

Common impact Definitions

1	Reduced Headway	Headway is the safety distance (time) between trains. Reducing headway means more trains can run on the track, handling more passengers. It allows more frequent train departures, thus improving capacity.
2	Travel time reduction	If trains run faster and smoother, travel time for passengers is reduced. This results in less waiting and shorter transit times. Minimized travel time affects capacity by enabling high-speed operations.
3	Capacity vs. Buffer	Buffer time is an add-on to the minimal running time to trade off operational diversity. Reducing buffers is part of the strategy to increase capacity, but it affects punctuality. It has a direct relation with robustness.
4	Alternative to infra expansion	Measuring if the existing infrastructure can manage capacity demand. If it exceeds, optimization by technology or methods is considered before resorting to infrastructure expansion. Higher track utilisation will help to save infrastructure investments in specific cases. By being able to run more / quicker trains on existing infrastructure, you may prevent constructing new lines to meet demand.
5	Negative effect on puntuality	Certain DATO concepts, especially GoA4, could negatively impact punctuality due to operational circumstances. More trains can lead to more delays, affecting punctuality.
6	Negative effect on energy savings	Introducing DATO to increase capacity affects energy consumption due to more frequent accelerating and braking. Higher capacity demand impacts energy savings strategies.
7	Increased operator	Using automation increases technological pressure on operators, leading to potential overwork and accidents. More trains require more manpower

Prioritized impacts



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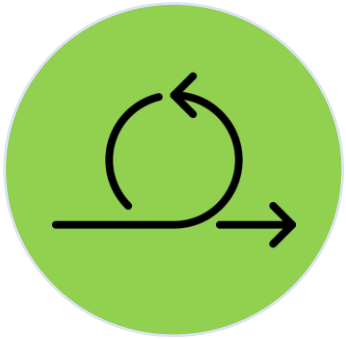
PROS AND CONS: PARTICIPATORY APPROACHES

Alignment

Ownership



Iterative process

Time

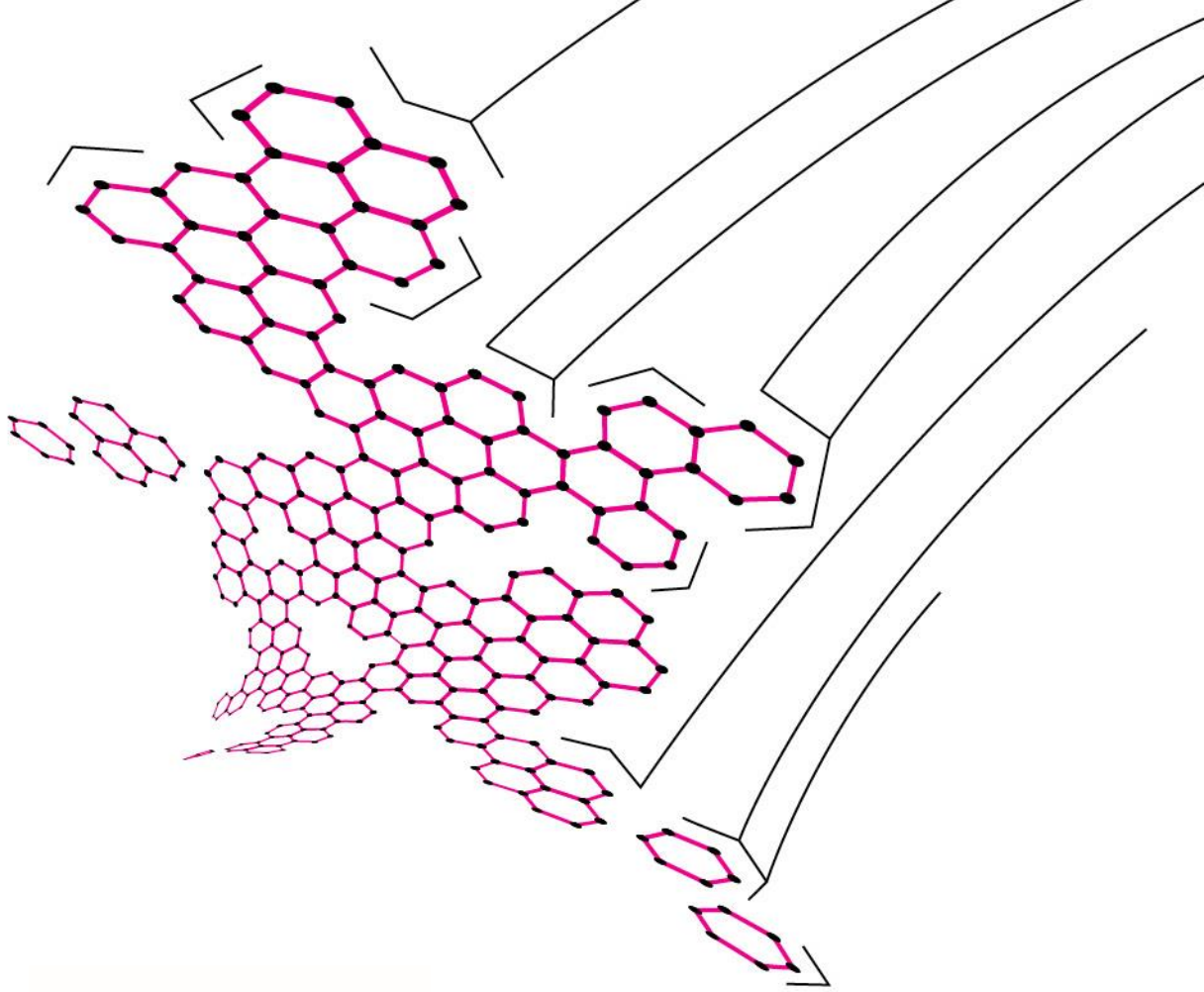
Long-term viability of operations

Anonymity of participants

Controlled feedback

Expert Dependency

BUSINESS CASE FOR AUTOMATIC TRAIN OPERATIONS



Europe's Rail

R2DATO

ProRail

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AUTOMATIC TRAIN OPERATIONS

Photo by Rob Dammers (CC BY 2.0 flic.kr/p/f1gwkE)

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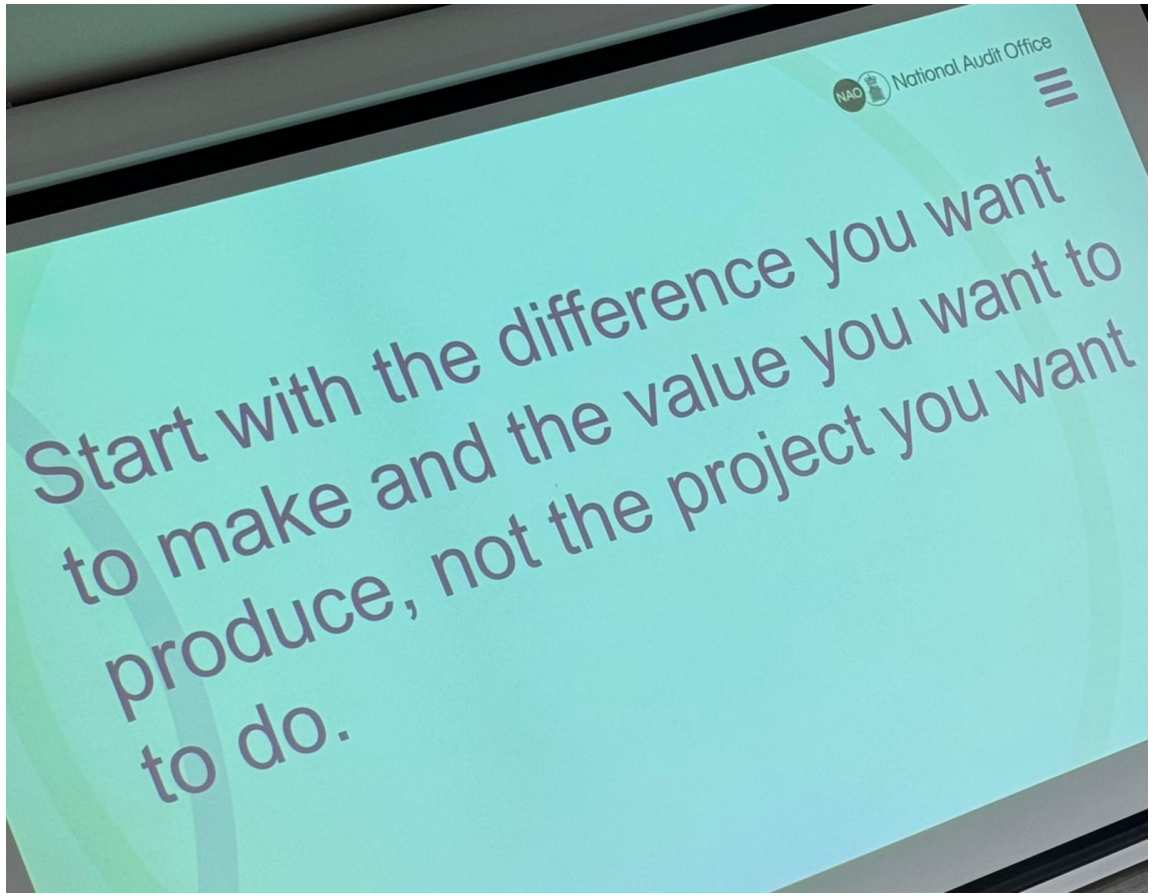
TECHNOLOGY AS ENABLERS FOR GRADES OF AUTOMATION

Grade of Automation	Door closure	Setting train in motion	Stopping train	Degraded operation in case of disruption
GoA1: Non- automated train operation	Driver	Driver	Driver	Driver
GoA2: Semi-automated train operation	Driver	Automatic	Automatic	Driver
GoA3: Driverless train operation	Attendant	Automatic	Automatic	Attendant
GoA4: Unattended train operation	Automatic	Automatic	Automatic	Automatic

Overview of Grades of Automation (GoA) levels (https://projects.shift2rail.org)

RAIL TO DIGITAL AUTOMATED UP TO AUTONOMOUS TRAIN OPERATION (R2DATO)



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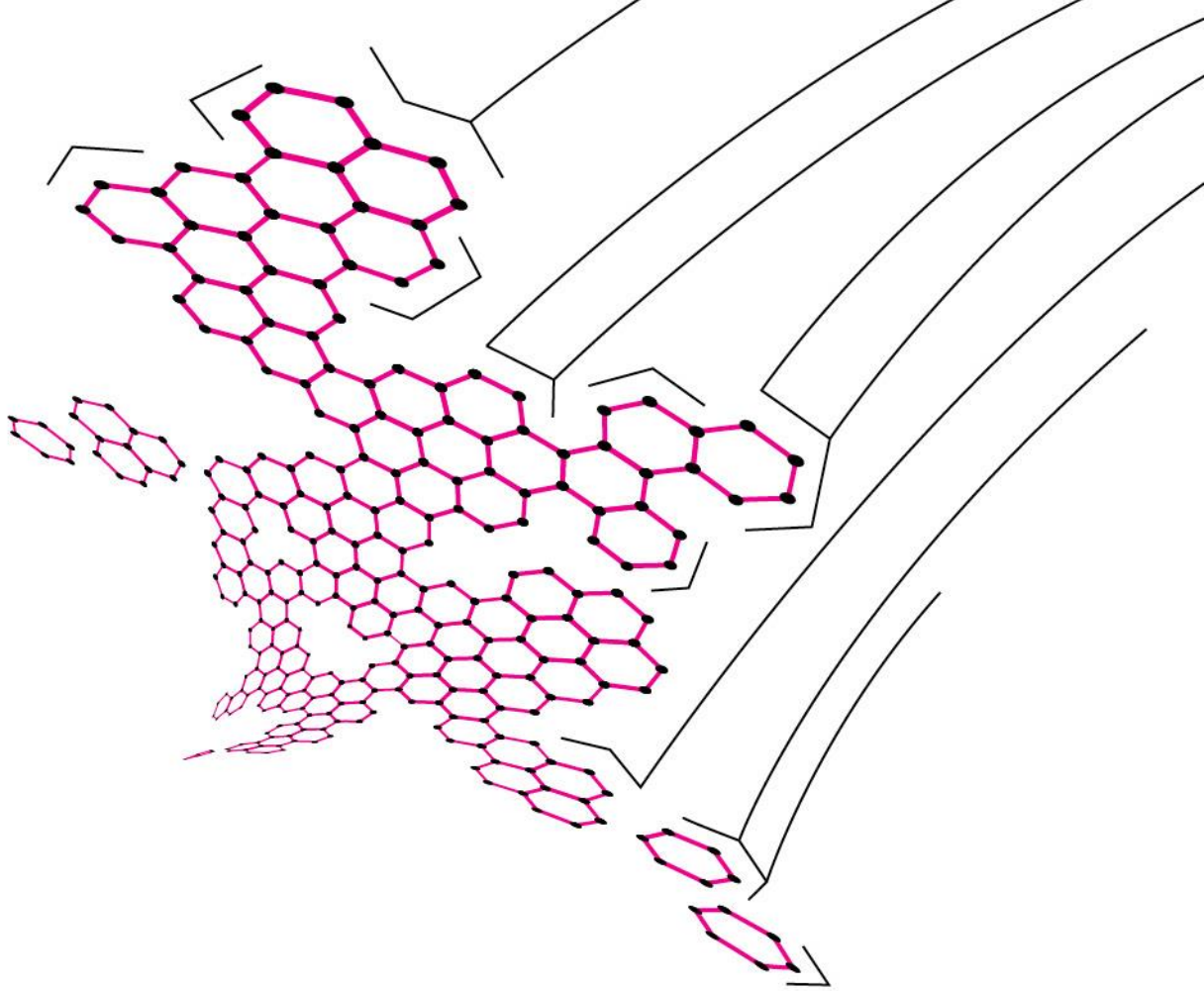
CONCLUSIONS



CONCLUSIONS – TAKE HOME MESSAGES

- A participatory approach is essential to ensure alignment and acceptation among involved parties
- Facilitation is key for the success for CBA approaches
- Maintenance and operations should not be overlooked - ensuring the long-term operational availability of engineering assets and infrastructure
- Modular and fit for purpose approaches aid in better business cases

THANK YOU

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