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# Opportunities of AI applications using DPP Data in the waste management industry

## Implications for Textiles

Ramin Nikzad-Langerodi, 20.10.2026

# Outline

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- Waste Management & Plastic Recycling
- Data Privacy & Federated Learning

# Introduction

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- How to turn variable feedstock into consistent product

# Introduction
## From Linear to Circular

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Rumetshofer et al. 2023

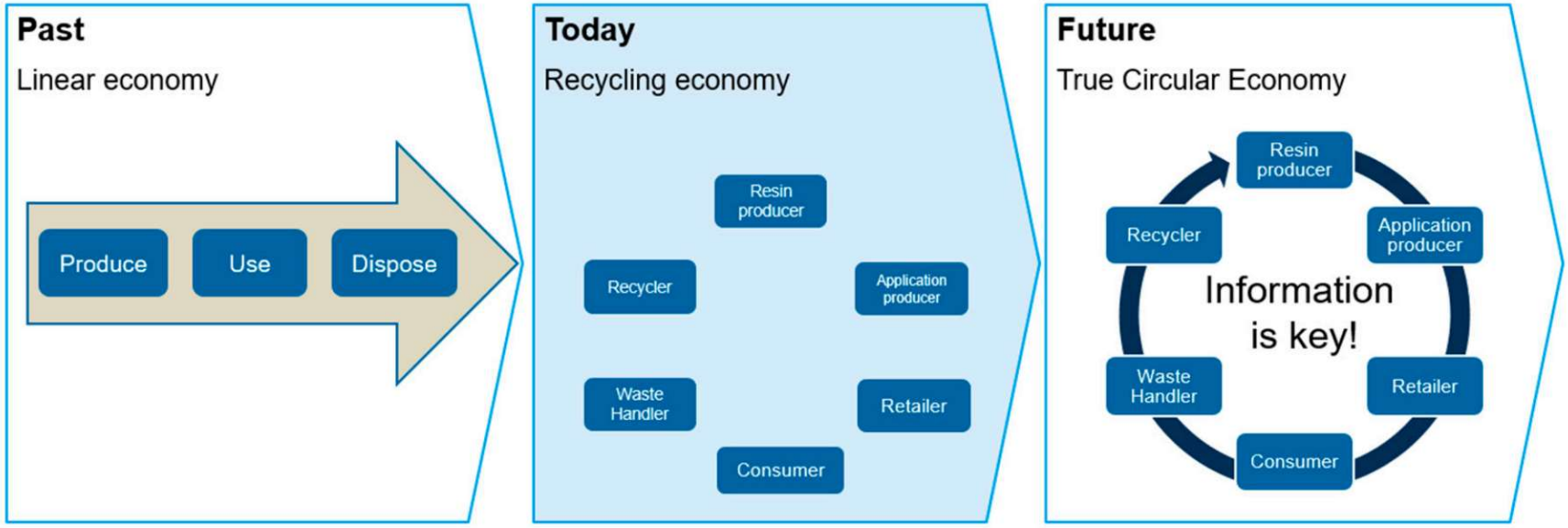
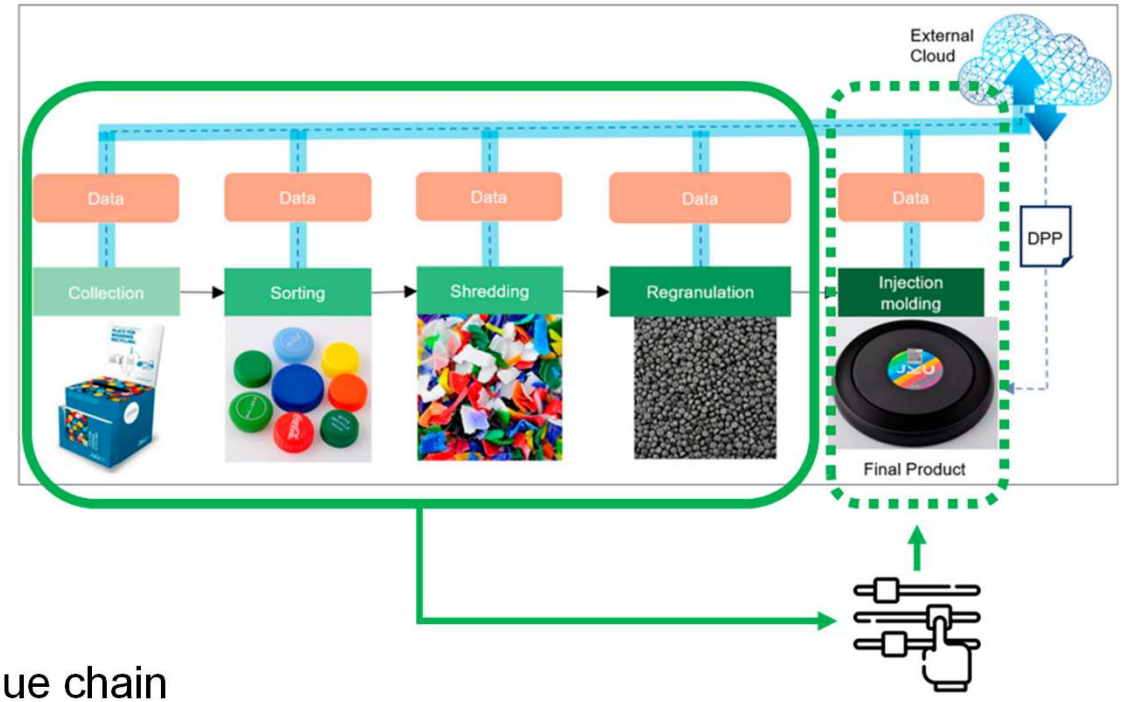



**Figure 2.** Business models of plastics industry for past, present, and future.

Rumetshofer, T., & Fischer, J. (2023). Information-Based Plastic Material Tracking for Circular Economy—A Review. *Polymers*, *15*(7), 1623.

# Introduction
## The Future

Rumetshofer *et al*. 2024

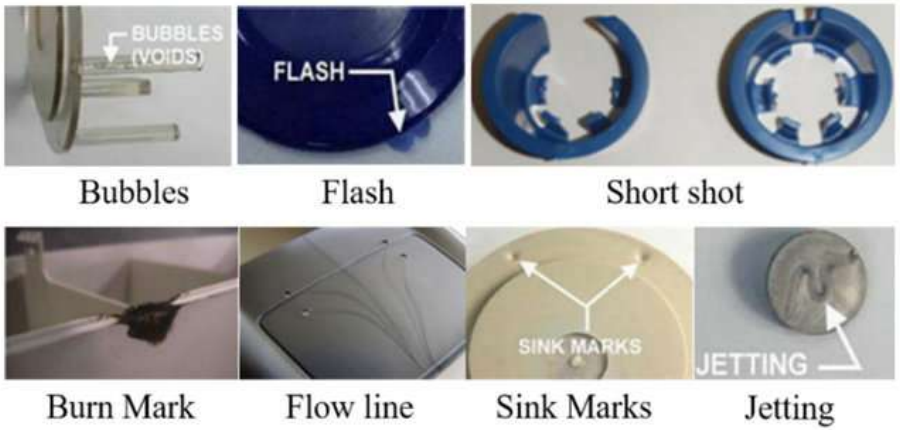



- Data-informed decision making along the value chain
  - Flexible processes for variable feedstocks

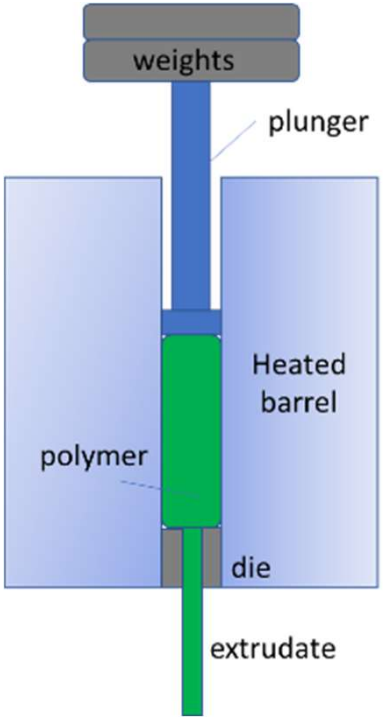
Rumetshofer, T., Straka, K., & Fischer, J. (2024). How the Digital Product Passport Can Lead the Plastics Industry towards a Circular Economy—A Case Study from Bottle Caps to Frisbees. *Polymers*, *16*(10), 1420.

# The Melt Flow Index (MFI) Dilemma

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Lee, H., & Ryu, K. 2020



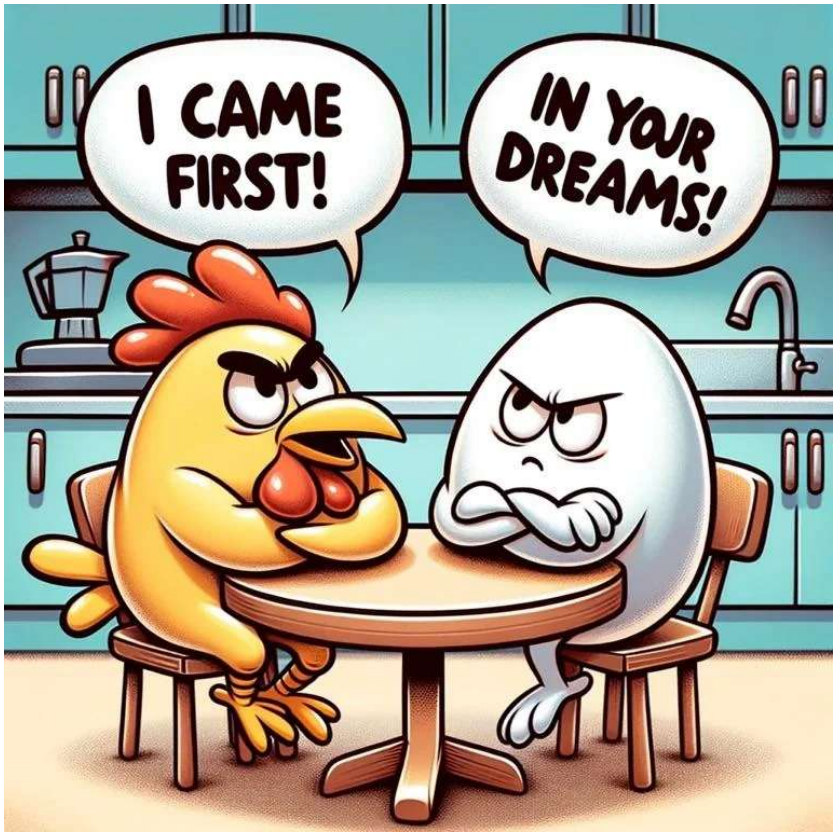

Source: https://www.campoly.com/

- The MFI does not tell the whole story
  → What information is relevant for downstream operations?

Lee, H., & Ryu, K. (2020). Dual-kernel-based aggregated residual network for surface defect inspection in injection molding processes. *Applied Sciences*, *10*(22), 8171.

# The Melt Flow Index (MFI) Dilemma

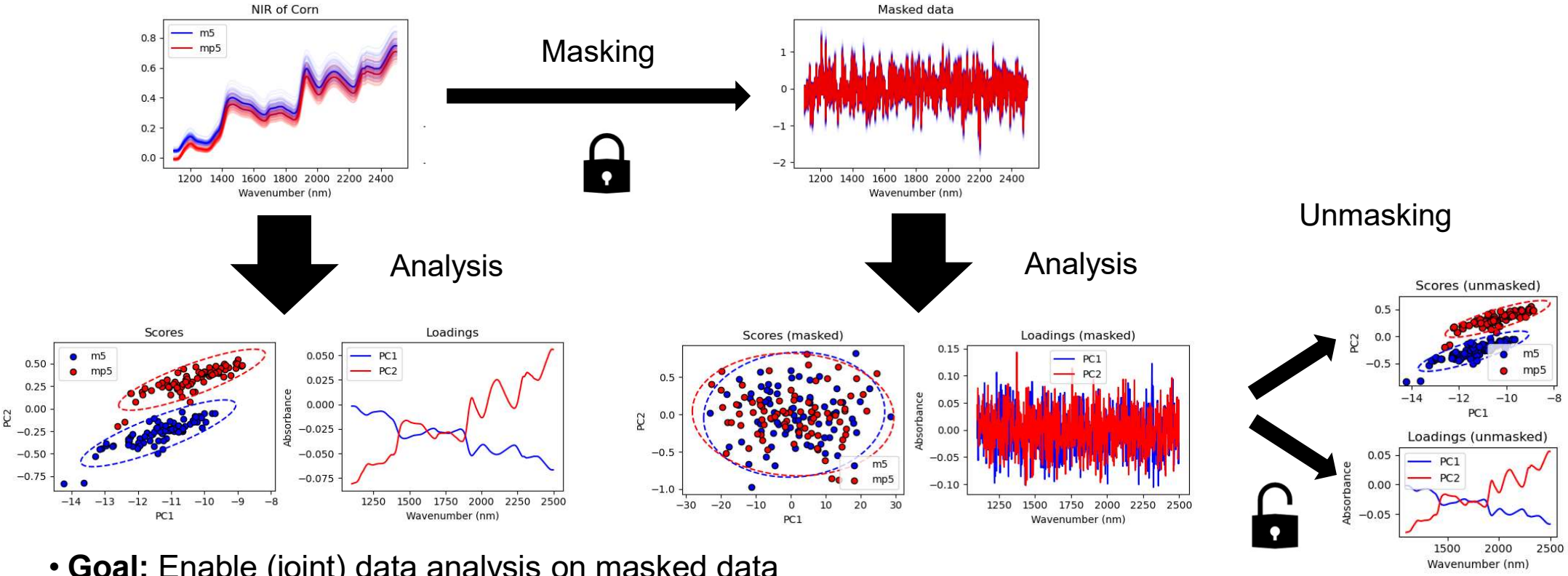
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- Only integrated/joint data analysis can tell for sure
  - → Requires incentives
  - → Account for data-privacy

# Federated Data Analytics

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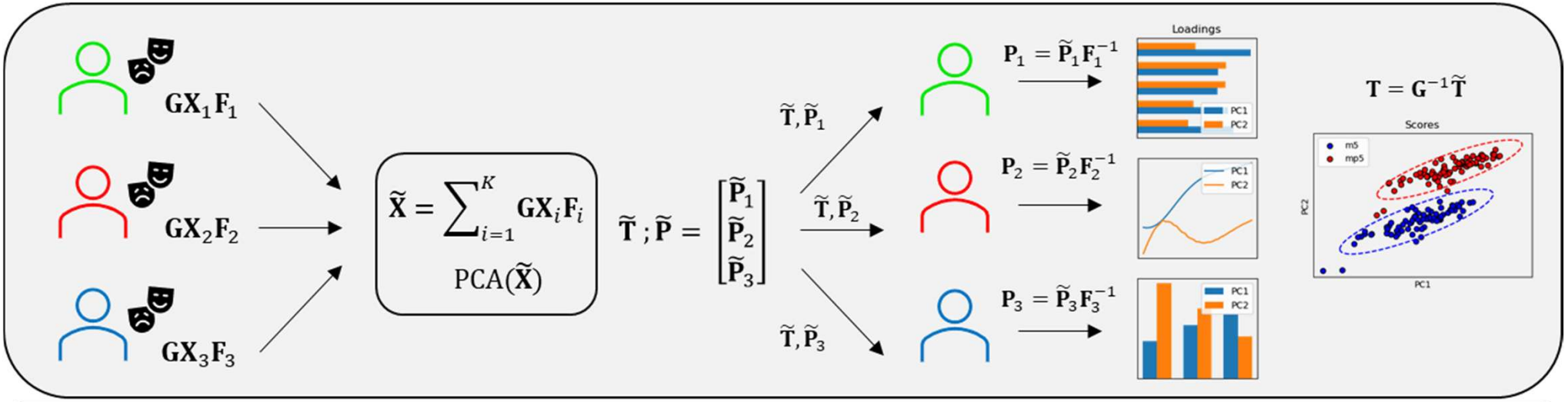



- **Goal:** Enable (joint) data analysis on masked data

  → Privacy Enhancing Technologies (Homomorphic Encryption, Differential Privacy, Random Masking, …)

# Federated Multivariate Stats/Process Modeling

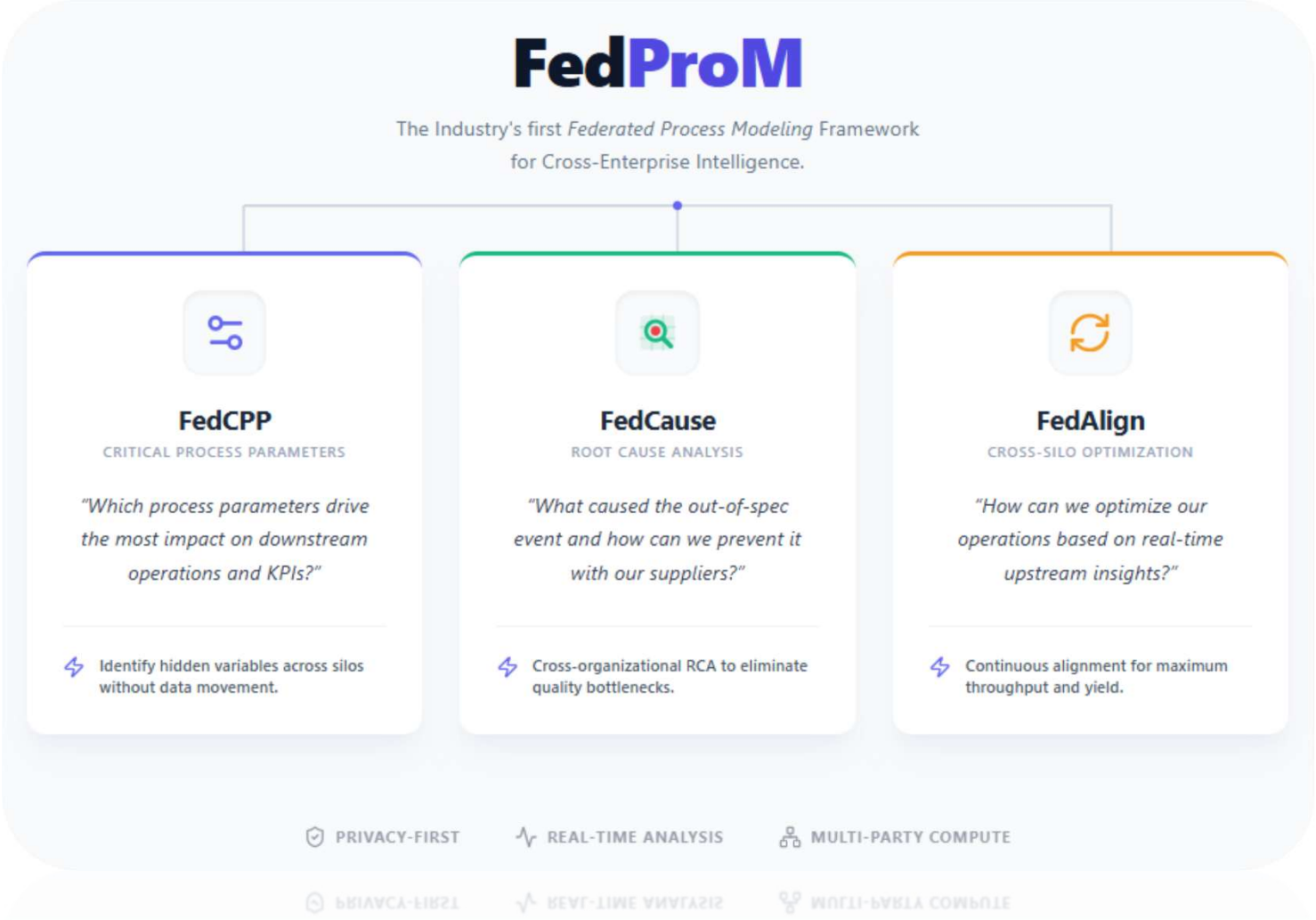
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| Clients | Computation Service Provider (CSP) | Local/Private Insights (CPPs, Variance) | Global Patterns/Insights (Seasonality, OOS,…) |
|---|---|---|---|

# The FedProM Framework

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# Federated Root Cause Analysis (FedCause)

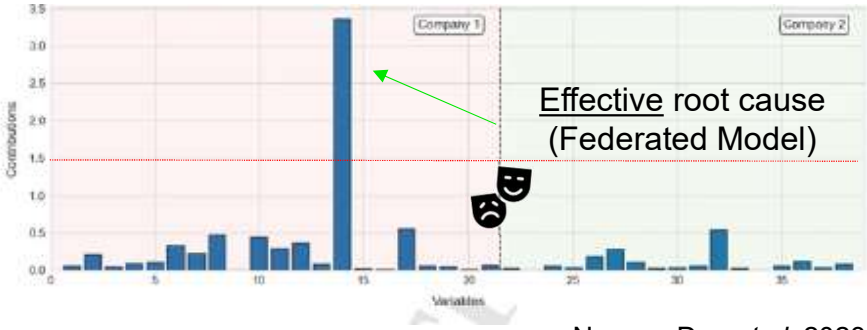
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Local Model

Presumable root cause
(Local Model)




Global Model

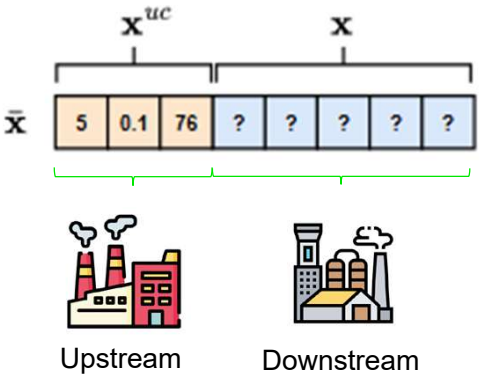


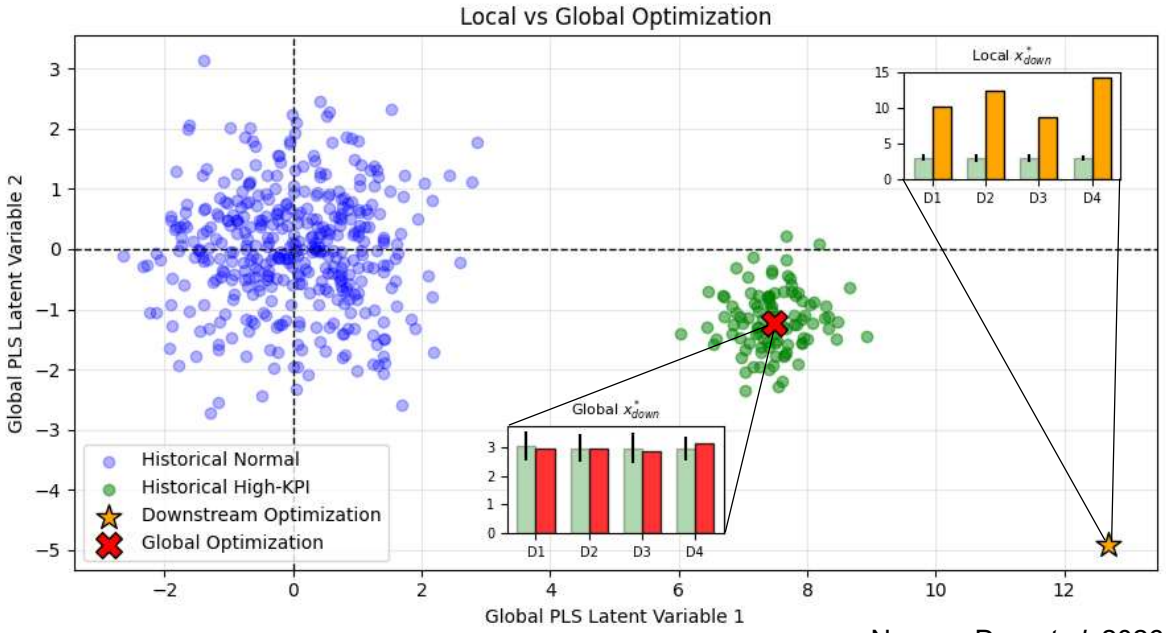

Nguyen Duy *et al*. 2023

- Local model: Something is going/went wrong
- Global model: Where/why did it go wrong

Nguyen Duy, Du, David Gabauer, and Ramin Nikzad-Langerodi. "FedMSPC: A Federated Multivariate Statistical Process Control Framework For Privacy-Preserving Process Modeling Across Company Borders." *International Conference on Mechatronics and Control Engineering*. Singapore: Springer Nature Singapore, 2023.

# Optimization (FedAlign)




Nguyen Duy *et al*. 2026

- Optimal parameter settings for downstream process
  - Given upstream has completed

Nguyen Duy, D., Nikzad-Langerodi, R., Scharinger, J., & Affenzeller, M. (2026). Vertical federated latent variable model inversion for collaborative value chain optimization. Discover Artificial Intelligence.

# Summary

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- Information flow along the value chain is pivotal
  → What information is relevant?
- Privacy concers hamper data exchange
  → Can we pass information without sharing data?
- (Vertical) Federated Learning
  Integrated Data Analytics → **What data is relevant**
  Federated Process Modeling → **Align up-/downstream operations**

# Acknowledgements

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Du Nguyen Duy



Dr. Mario Pichler

https://github.com/software-competence-center-hagenberg/vflbench

Thank you!

Open for Collaboration

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FFG Forschung wirkt.

Bundesministerium Digitalisierung und Wirtschaftsstandort

Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie

ober österreich

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