International Council on Systems Engineering
A better world through a systems approach

Systems-of-Systems Engineering Challenges: Experiences from the Road Construction Domain

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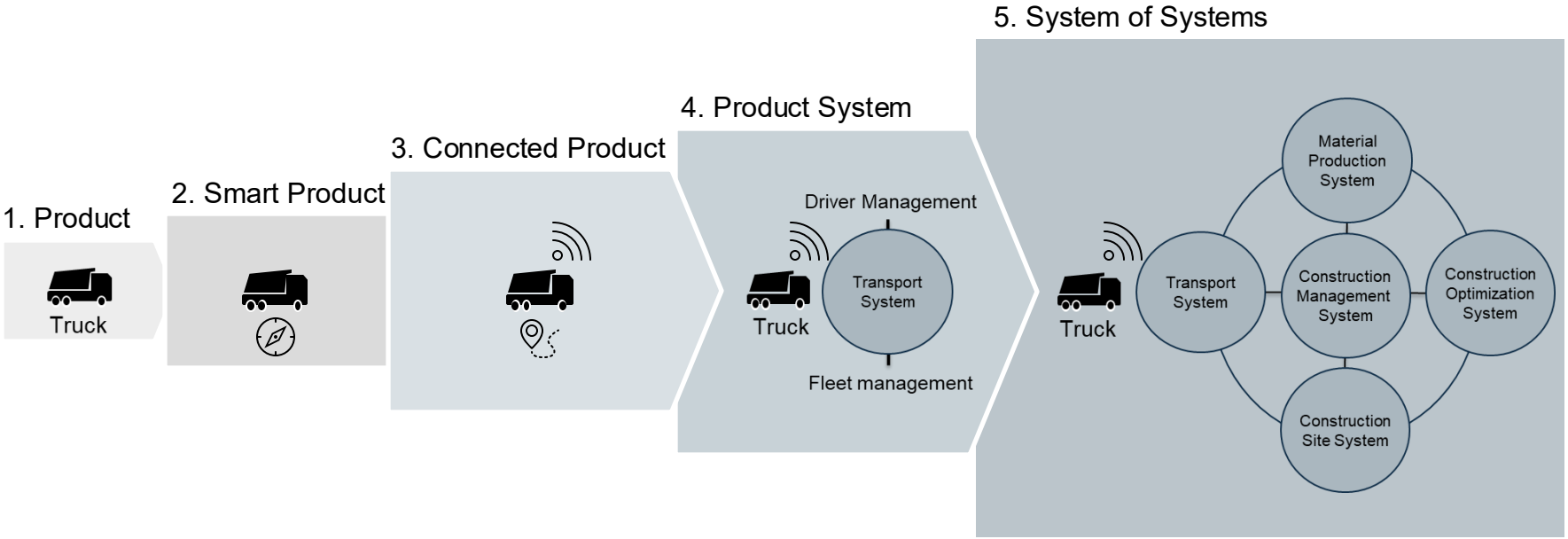
Introduction: Digital Transformation



The five phases according to Porter & Heppelmann (2014)

Summary: Failures in digital transformation reaching stage 5

Practical Challenges from Case:

- Collaboration
- Information gathering
- Information exchange

SoS challenges identified:

- SoS Structure & boundaries
- Information representation
- Business models and incentives

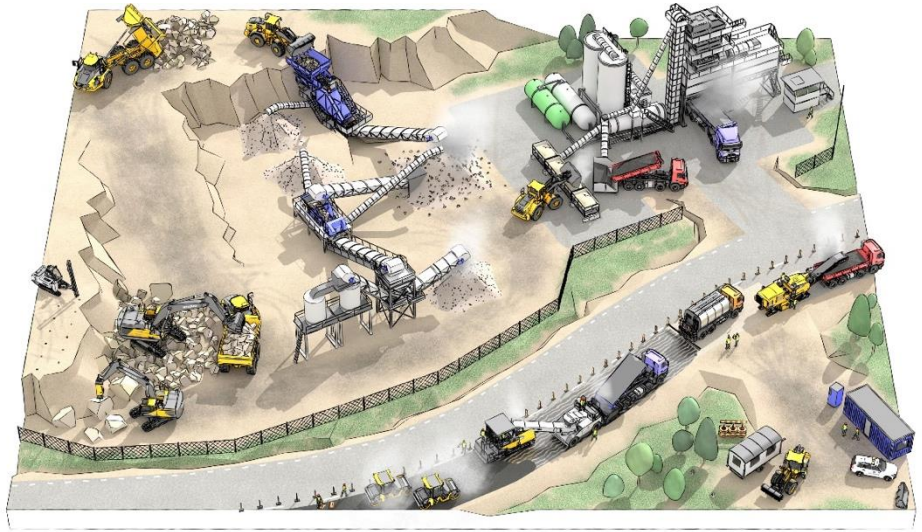
The Case study - Road (asphalt) Maintenance.

High societal costs

Low productivity

Complex sequential operations

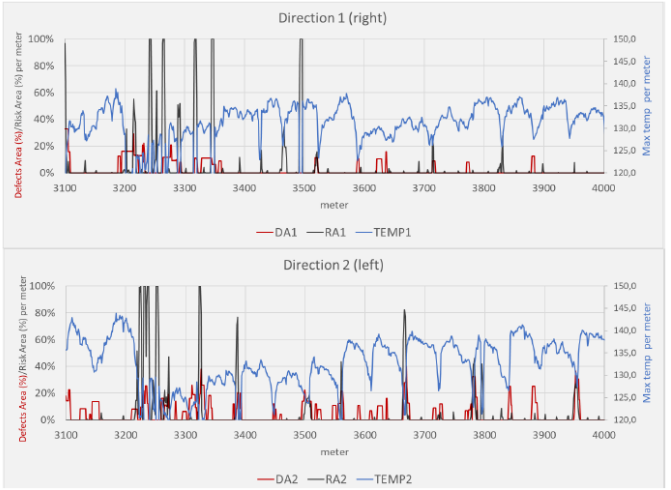
System-of-systems landscape



Quality affects the road's lifespan.

The temperature of the asphalt during paving affects the quality.

Deviations in temperature measurements during asphalt paving show a strong correlation with defects already after 2.5 years. *



*Palmi, A. & Truu, M. (2023). Bonus system contract – smart motivator for improving paving quality and sustainability. Presentation at XXVIIth World Road Congress, Prague, Czech Republic.

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Complex operation to make efficient, maintaining quality

Production pace
Queuing
Capacity
…

Travel time
Truck load capacity
No Trucks
…

Speed (kg/sec)
Road width and health
Wells
Crossings
….

Asphalt plant → Transports → Work site

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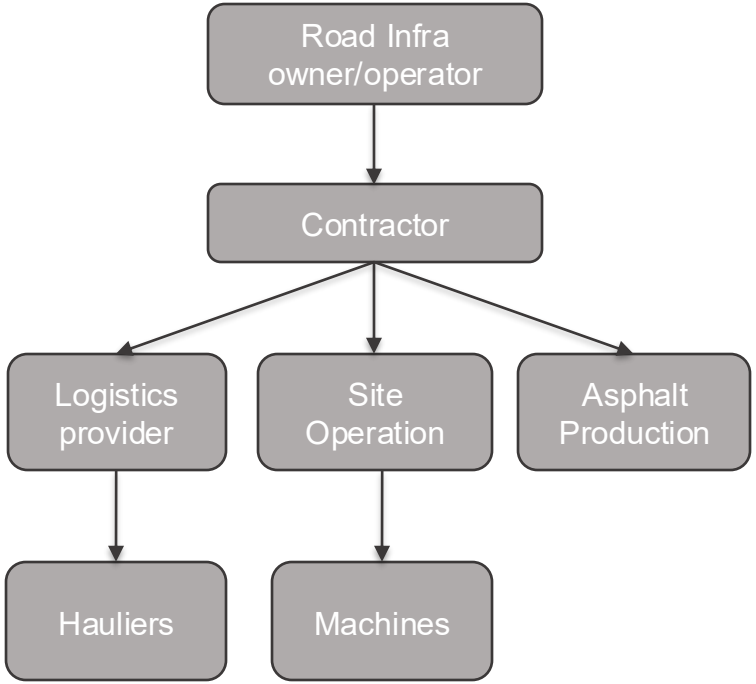
The Case study – Key Actors

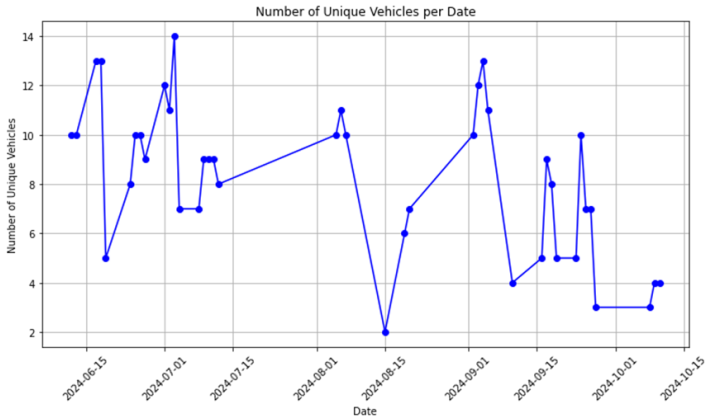
Picture courtesy of Volvo Construction Equipment – © 2000 – 2025 Volvo Construction Equipment – All rights reserved



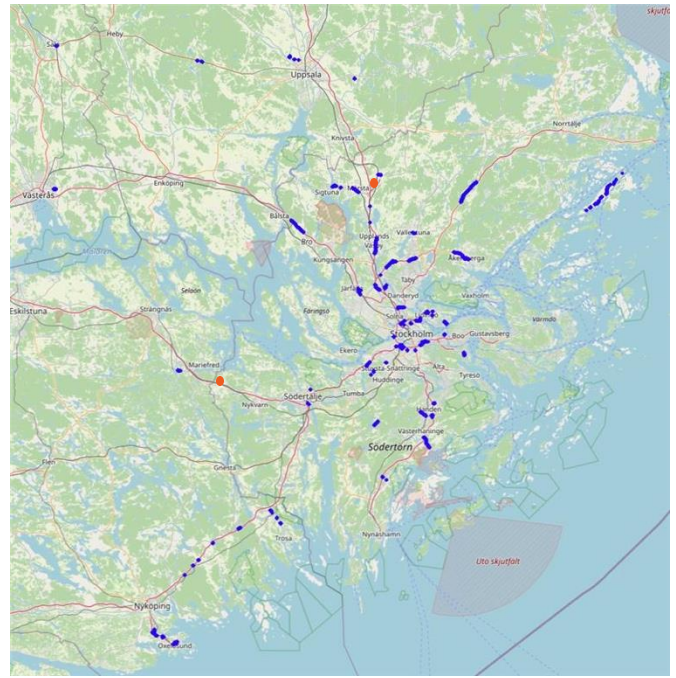
Charactisrics of the Logistics operation

Trucks used during ~40 shifts 2024 for one crew/paver:

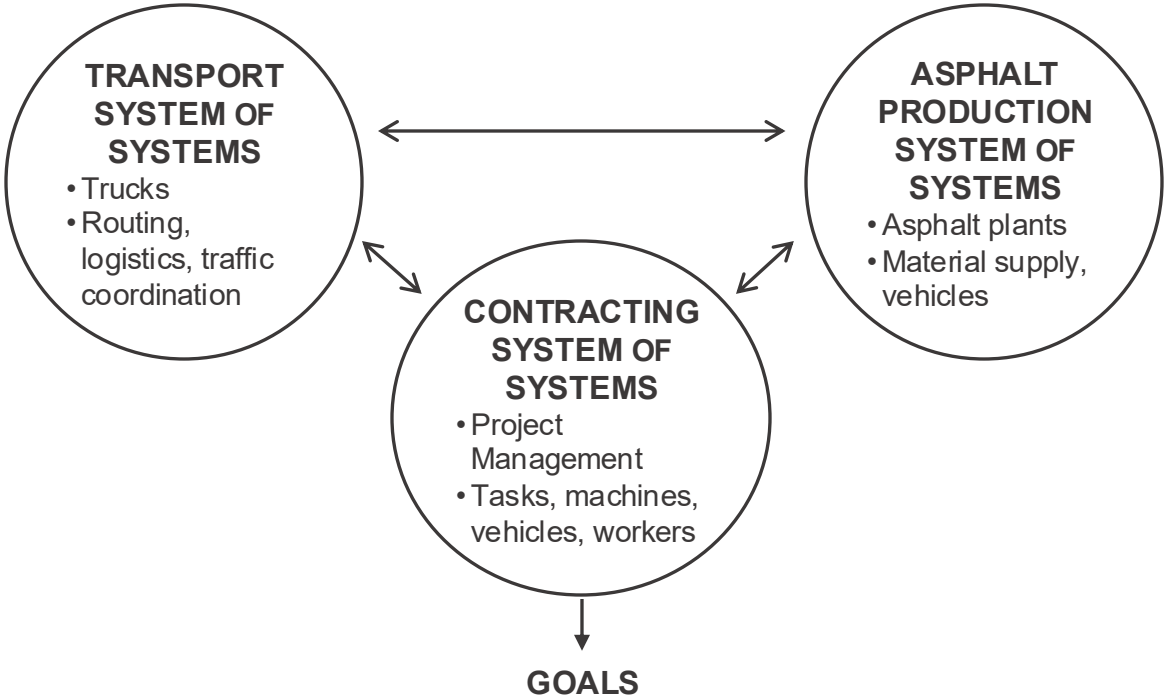
- Up to 14 trucks per shift/day
- 45 unique truck combinations
- 30 different haulage companies/owners



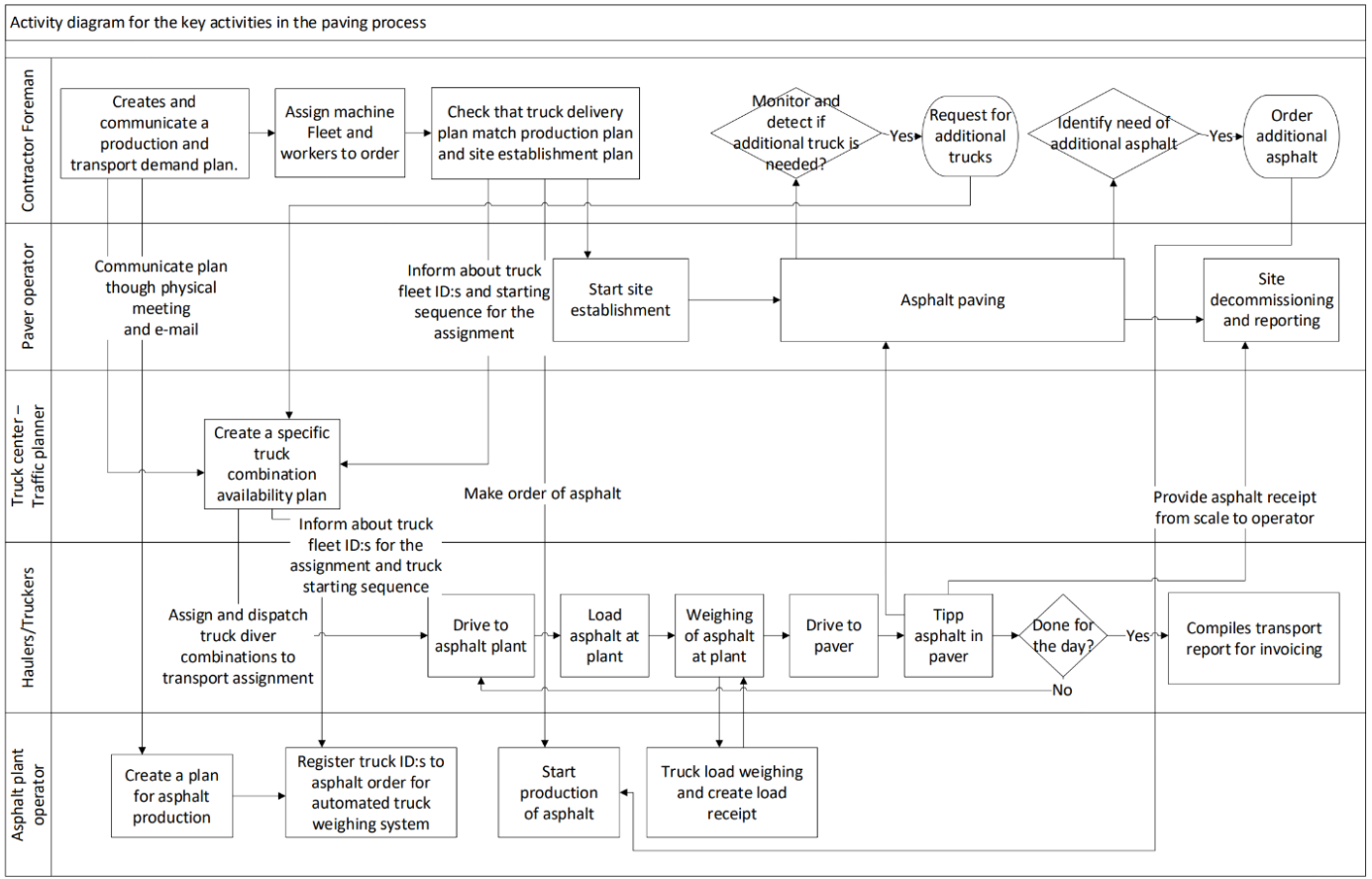
- Asphalt plants
- Road asphalt maintenenace



Collaboration of independent Systems of Systems in road pavement maintenance



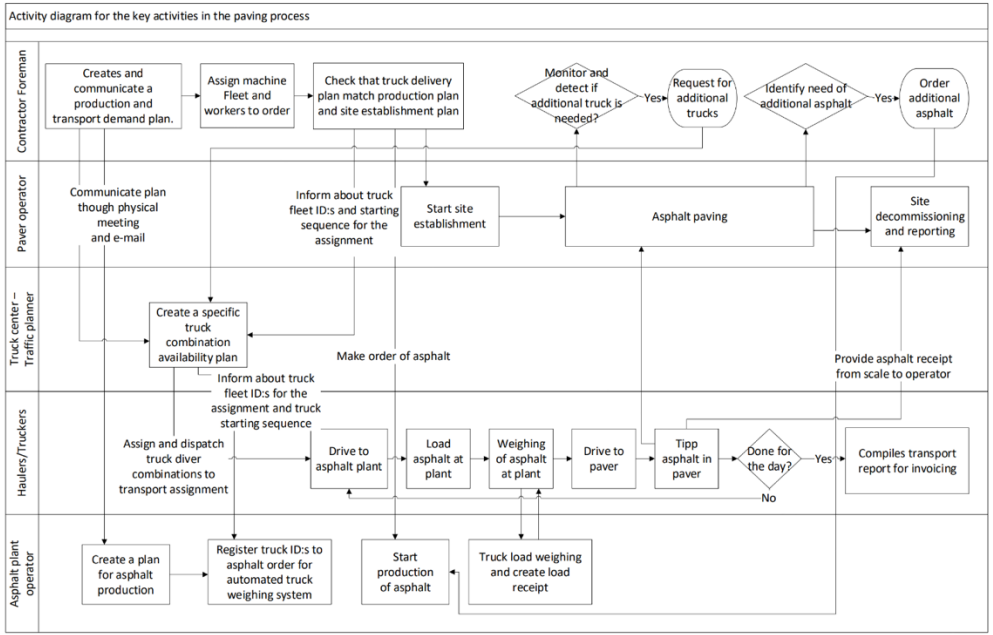
The Case study: improvements



The Case study: improvements

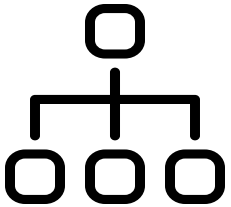
Improvements:
- Digital documentation
- Optimization of operation
- Automation of processes

Challenges
1. Collaboration and coordination
2. Information gathering
3. Information exchange in operation



Derived Generic SoS Challenges

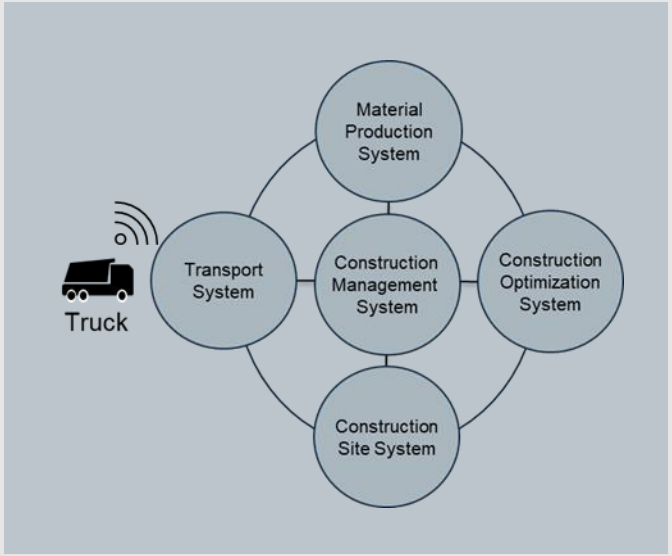
- Structure of the SoS



- Information representation and Exchange

- Business models and incentives

Conclusions & Summary



We have identified practical challenges:

- Collaboration and coordination
- Information gathering
- Information exchange in operation

Generic SoS challenges:

- Structure of the SoS
- Information representation
- Business models and incentives

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