SWEDISH MANUFACTURING CONFERENCE · SÖDERTÄLJE · 20–21 MAY 2026

Dynamic SALSA

Dynamic scheduling for flexible, human-centred warehouses — and what a camera makes possible.

Erik Flores-García
Assistant Professor · KTH

Yongkuk Jeong
Assistant Professor · KTH

THE HIDDEN COST OF MANUFACTURING

20%

of all logistics cost is warehousing — space, labour and variability.

THE WORK THAT ABSORBS THE CHAOS

Picking leans on the individual.

- **High mix**
- **Manual & physical**
- **Every operator differs**
- **Fewer, newer people**

New & seasonal staff, limited on-the-floor guidance, a shrinking labour pool — so the same task takes very different time from person to person.

WHY WAREHOUSES STAY STUCK

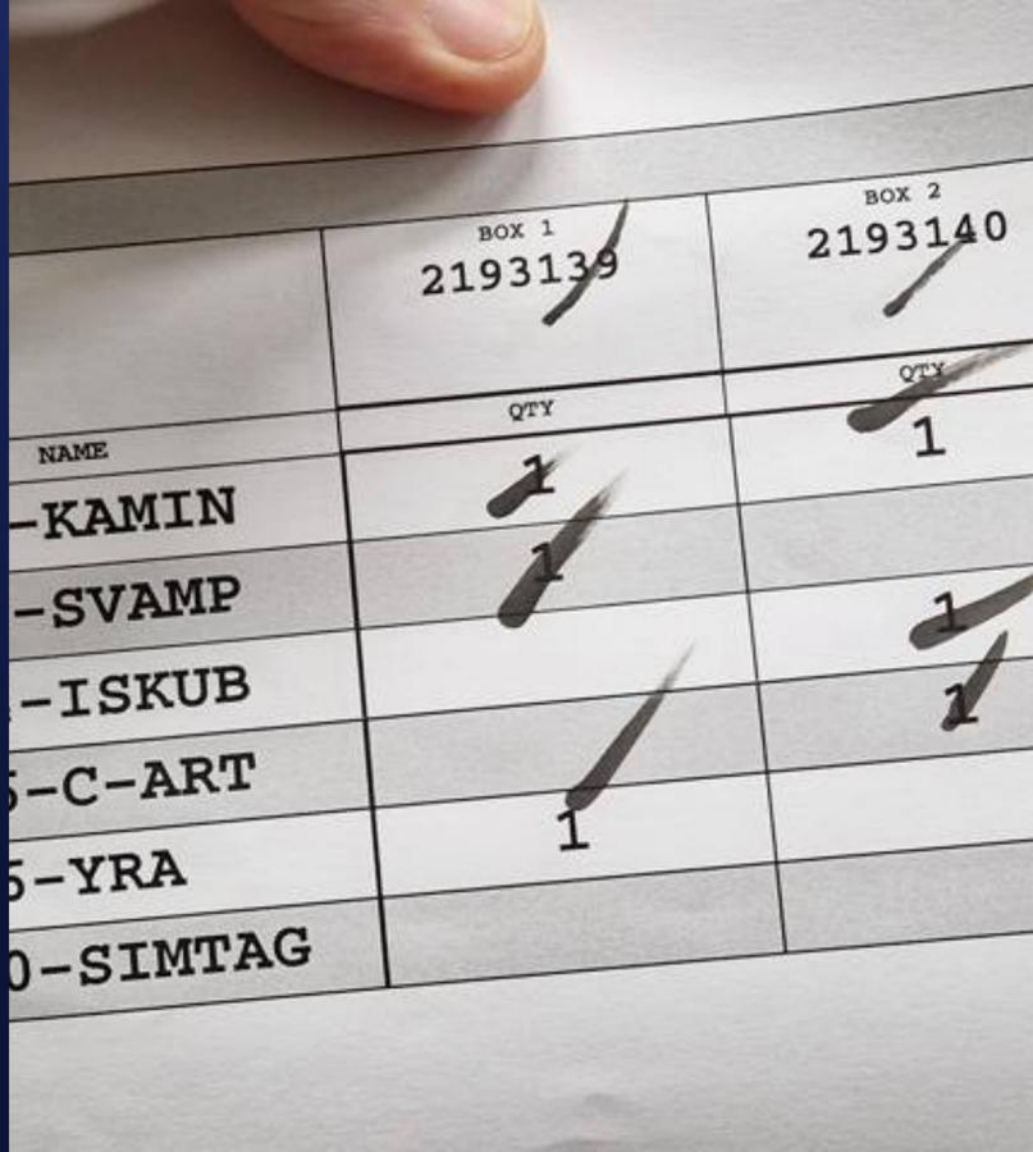
Two gaps.

01 Not enough information

We rarely know what operators actually do on the floor — or how long it really takes.

02 Unbalanced, unsustainable workload

Heavy items, repetition and one-size-fits-all routes — rarely tuned to the individual.



WHAT WE REALLY MEAN BY “DYNAMIC”

A bus line — or on-demand?

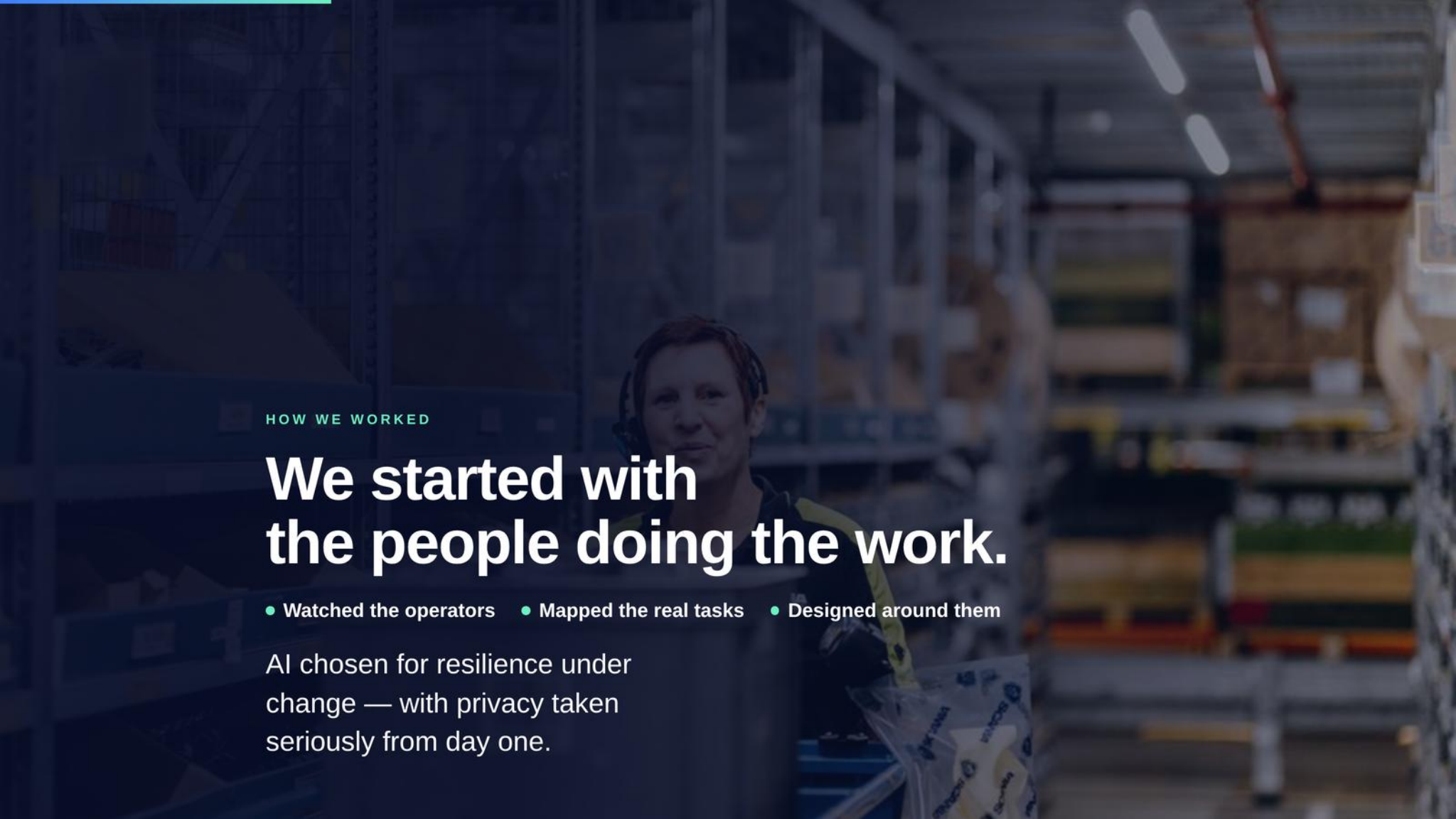
BUS LINE fixed route & timetable

Bus — distance walked 38 m

ON-DEMAND goes only where needed

On-demand — distance walked 37 m

On-demand picking is dynamic scheduling.



HOW WE WORKED

We started with the people doing the work.

- Watched the operators
- Mapped the real tasks
- Designed around them

AI chosen for resilience under change — with privacy taken seriously from day one.

BUILT AROUND THE OPERATOR'S NEEDS

The workflow answers four questions.

01 **Where to go?**
AI dynamically schedules the picking route around demand, distance and workload.

02 **What to do?**
The right information reaches the operator on a tablet, at the moment of the pick.

03 **How did we do?**
A camera interprets what actually happened — setup, search, travel, picking.

04 **How to improve?**
The data feeds back, so the schedule keeps learning.

FROM THE FACTORY TO THE LAB

A real problem, brought into the lab.

The real problem
Order picking at Scania

→

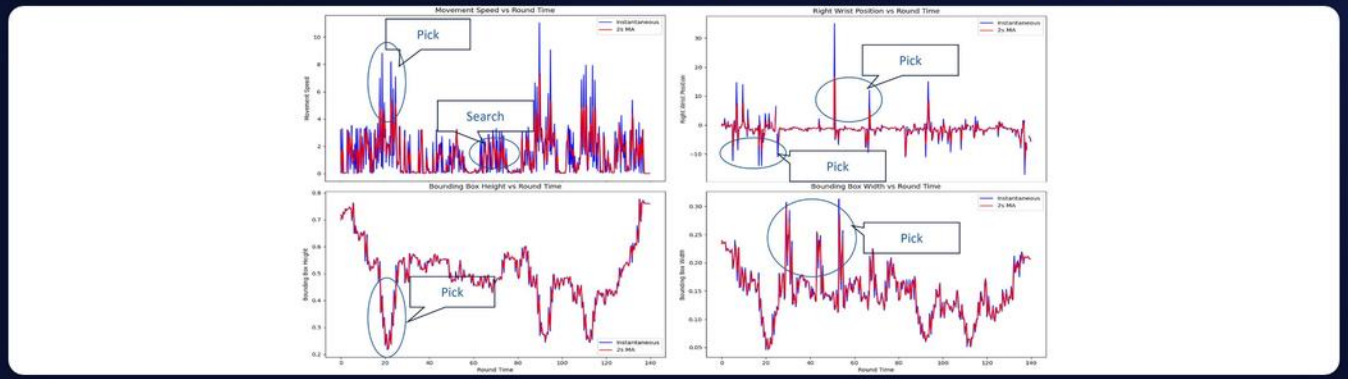
Designed & analysed together
Data, software, partners

→

Prototyped & tested
KTH Production Logistics Lab

We rebuilt the factory picking problem as a working testbed — real orders, carts and operators — so we could try ideas safely before the floor.

HOW DID WE DO? — WE TAUGHT A CAMERA TO READ THE WORK



From the captured motion we can tell picking from searching and travelling — in real time.

WHAT WE FOUND

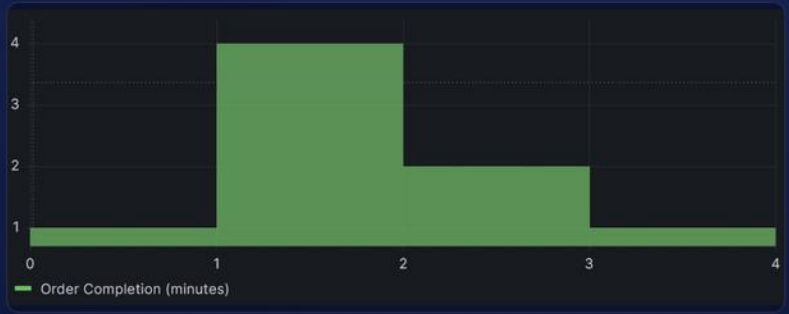
Most of the time isn't picking.

Picking itself is only about a tenth of the time — the rest is travel, search and setup. Exactly what better scheduling can cut.

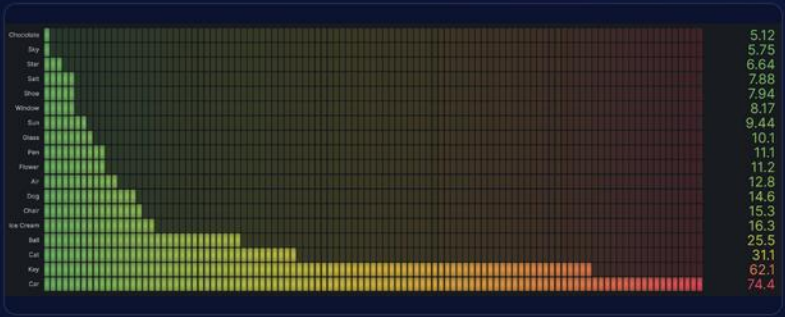
HOW TO IMPROVE? — THE KPIS WE FEED BACK

More visibility, closer to real time.

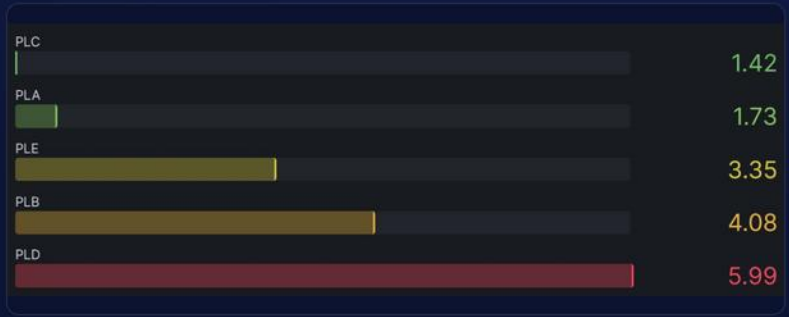
Mean lead time · picking list



Frequency vs. completion



Picking time per product



Order completion time

HOW WE KNOW — NOT JUST THAT WE HOPE

How we know it works.

01 **A working testbed, not a slide**
Rebuilt in the KTH Production Logistics Lab with real orders, carts and operators — a system you can run, not only describe.

02 **Measured against a baseline**
Adaptive scheduling compared with fixed routes on the same orders — so the gain is a difference, not an impression.

03 **Vision checked against the real work**
The camera's reading of setup, search, travel and picking was compared with what operators actually did.

04 **Built to travel**
The method isn't tied to one shelf layout or product set — the aim is something other warehouses can adopt.

WHERE THIS GOES BEYOND THE STATE OF THE ART

What's genuinely new.

01 Workload-aware scheduling
We schedule on workload and cart capacity, not only walking distance — balancing the human, not just the route (Wang et al., 2025).

02 Human-centred by design
The vision system is built around the operator and privacy from the start — not added afterwards.

03 One idea across two domains
The same camera approach spans picking in Sweden and assembly in Korea — evidence it generalises.

04 Feeding the standards
Our digital-twin work contributes back to standardisation (ISO 23247), so others can build on it.

AND HERE'S THE INTERESTING PART

The same camera can study the operator.

Point it at the worker and it reads their motion — and early results suggest it can estimate standard time, even per individual, plus a read on ergonomic load.

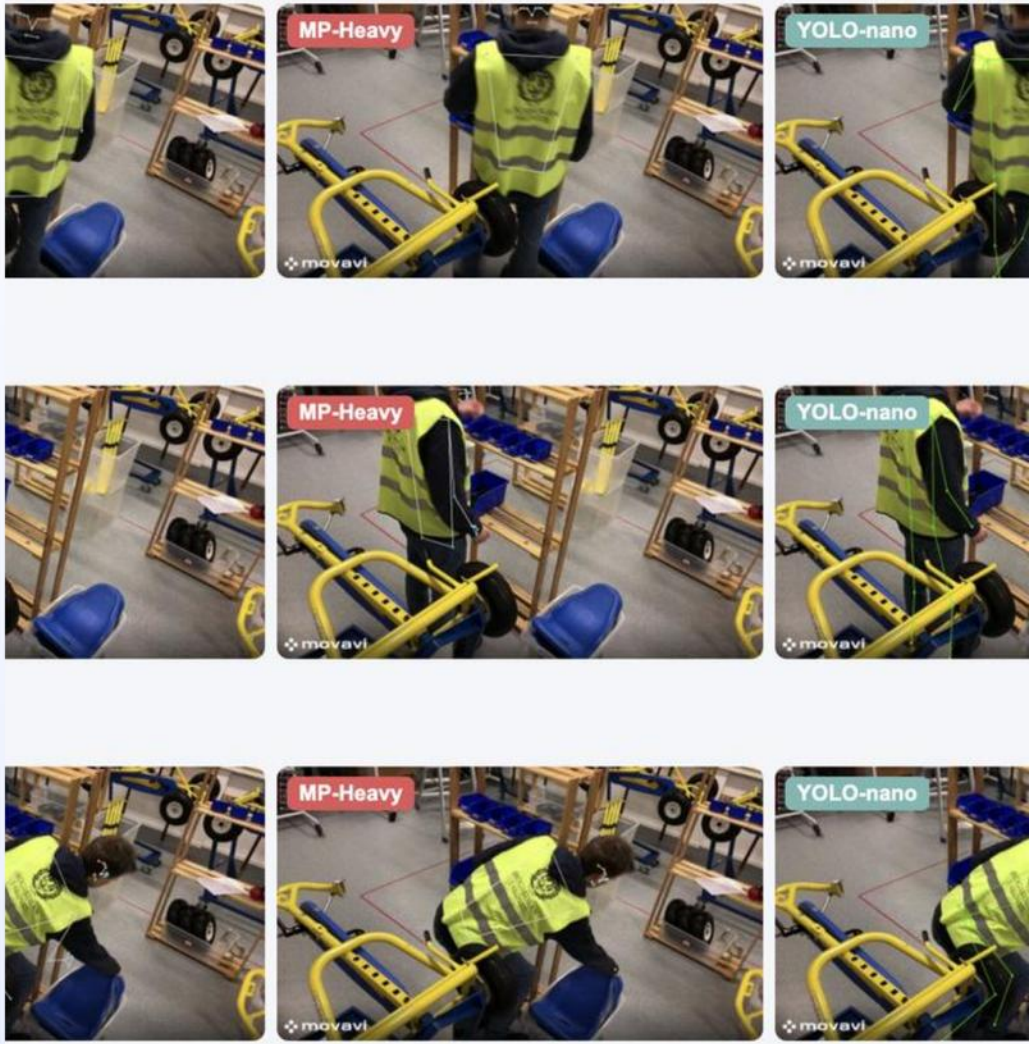
Our TIMEBLY 2 project · funded by Vinnova

CAMERAS AT WORK ARE SENSITIVE

We took privacy seriously.

- **Skeleton, not faces**
- **Faces blurred**
- **Support, not surveillance**

We keep the moving skeleton and blur identities — the goal is better, safer work, not watching people.



BACK TO WHERE WE STARTED

The two gaps — now narrower.

GAP 1 · INFORMATION

Not enough information

We rarely knew what really happened on the floor.

→ improved with AI vision

More of the work — setup, search, travel, picking — becomes visible and traceable, closer to real time.

GAP 2 · WORKLOAD

Unbalanced, unsustainable workload

Heavy items, repetition and one-size-fits-all routes.

→ improved with workload-aware scheduling

Our scheduler balances operator workload and cart capacity — not just walking distance (Wang et al., 2025).

BENEFITS AND IMPACT

Who benefits — and how.

Who benefits

Operators & engineers

Companies big & small

Standardisation bodies

Universities & students

Impacts

Worker well-being & performance

Privacy & data protection

Gender equality & diversity in AI

The value of human work in the age of AI

Market opportunities

New products & digital services

Cognitive support for operators

Resilience

Flexibility

BEING HONEST ABOUT THE EDGES

What we don't know yet.

01 Lab, not full scale
It works in a realistic testbed — the full warehouse floor, at volume, is the next test.

02 One use case so far
Built around Scania picking; other layouts and product mixes still have to prove it.

03 Vision has limits
Occlusion, lighting and unusual motions still challenge the camera.

04 Standard time is early
The per-operator timing is promising — not yet a validated measurement system.

05 Dynamic isn't free
More adaptivity means more compute, integration and change for the people on the floor.

PART OF A BIGGER TEAM

A Sweden–Korea project.

SE **Sweden — logistics**

Our side: order picking in warehouses, with AI vision and adaptive scheduling.

KR **Korea — assembly**

Partners took the same computer-vision idea to railway-vehicle manufacturing — tracking assembly objects and building a digital twin.

Funded through Eureka SMART — two consortia, one idea: AI vision making manufacturing flexible and human-centred.

NOT AN ENDING — A DIRECTION

Where this is heading.

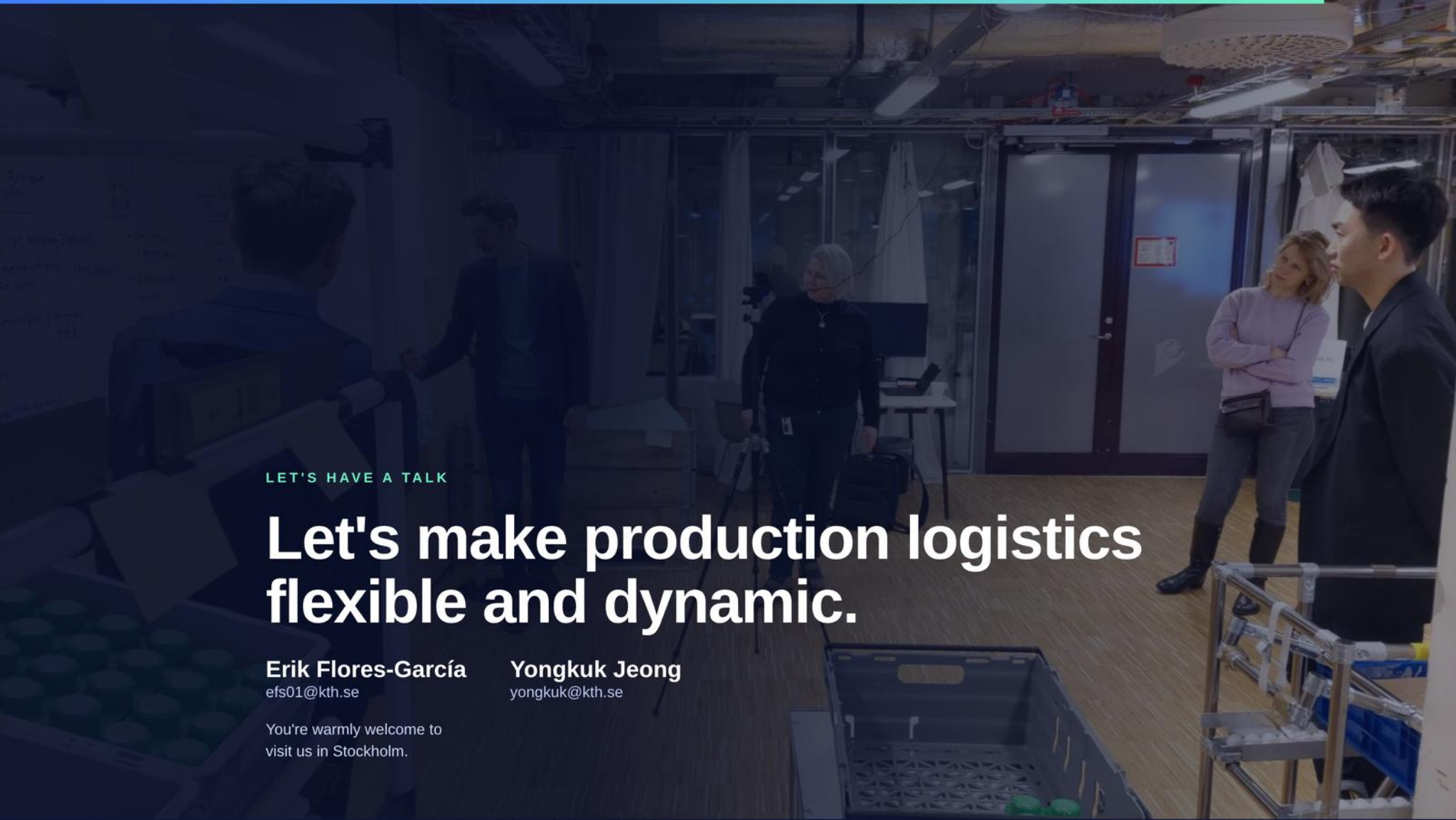
Human-centred, camera-informed, adaptive scheduling is exactly the agenda of the next big European call:

EU

Human / AI Collaboration for the Workforce of the Future

Horizon Europe · HORIZON-CL4-2027 (Made in Europe / AI, Data & Robotics) — co-learning, adaptive automation, well-being and inclusion.

We're still at the intention stage — but if this resonates with your work, come talk to us.



LET'S HAVE A TALK

Let's make production logistics flexible and dynamic.

Erik Flores-García
efs01@kth.se

Yongkuk Jeong
yongkuk@kth.se

You're warmly welcome to visit us in Stockholm.

IF YOU WANT TO DIG DEEPER

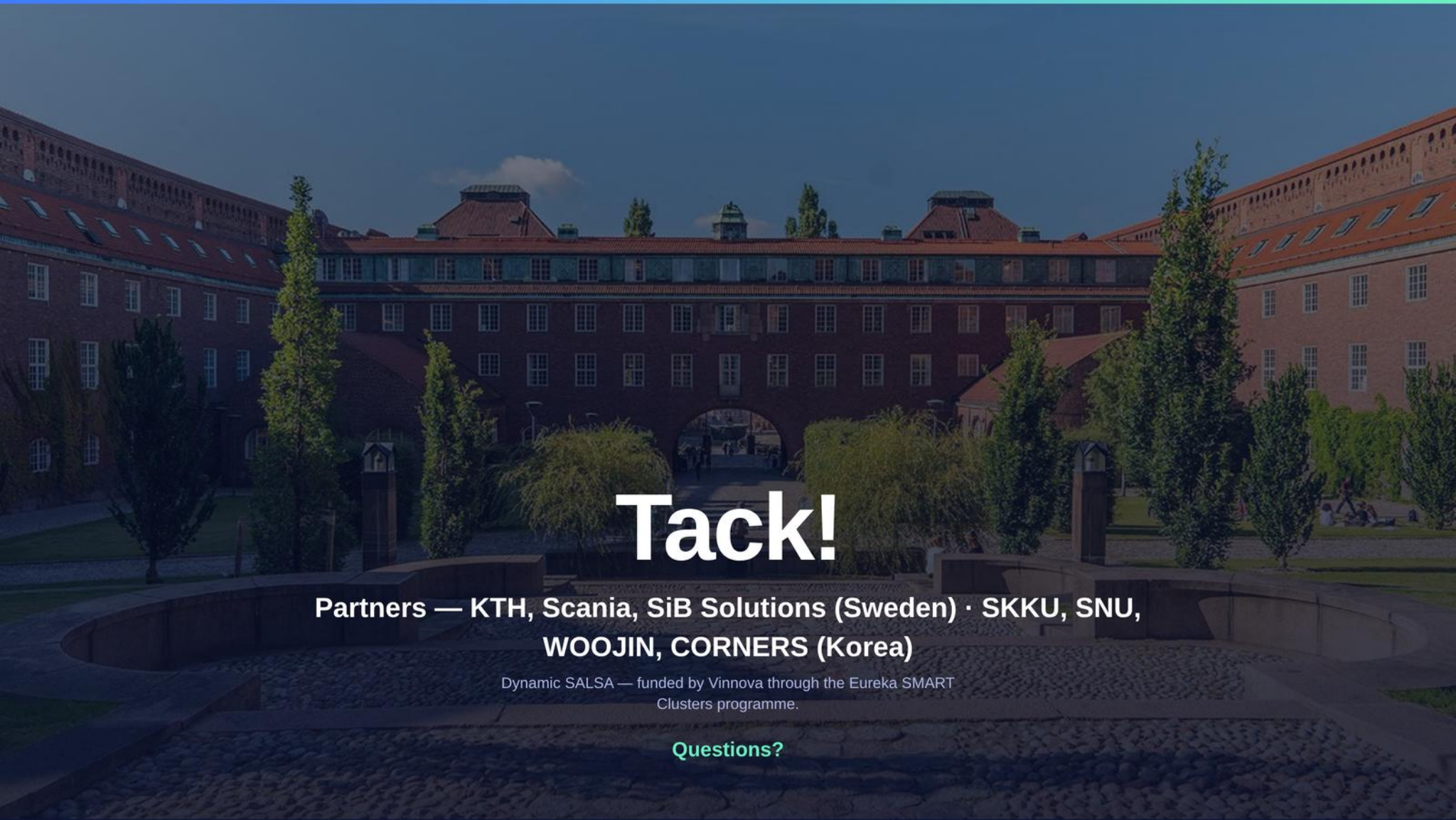
Selected reading.

1 Wang, X. et al. (2025) Dynamic multi-tour order picking based on attention-aware deep reinforcement learning. *Robotics & Computer-Integrated Manufacturing* 94, 102959.

2 Flores-García, E. et al. (2026) AI-enabled vision systems for human-centered order picking. *Int. J. Production Research* 64(5), 1785–1812.

3 Zafarzadeh, M. et al. (2025) A framework and system architecture for value-oriented digital services in production logistics. *Int. J. Production Research* 63(1).

4 Cho, K. et al. (2025) Graph Attention Network-based DRL for dynamic human order picking. *APMS 2025*, 450–465.



Tack!

Partners — KTH, Scania, SiB Solutions (Sweden) · SKKU, SNU, WOOJIN, CORNERS (Korea)

Dynamic SALSA — funded by Vinnova through the Eureka SMART Clusters programme.

Questions?