RAKENNUS· TEOLLISUUS

# The Confederation of Finnish Construction Industries: Product information and supply chain digitalization development project

## Engineer-To-Order products

**BETK-workgroup**

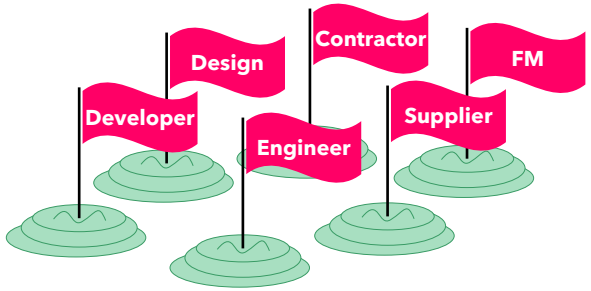
2025-04-15 / Presentation

# Contents

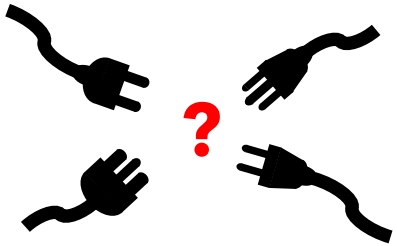
1. Motivation
2. Background
   - Manufacturing strategies
   - T-Model
   - Preliminary study on the current state of the ETO Supply Chain
3. Project Organization
4. Work Objective
   - Road-map
   - Future State Data Flow Architecture for an ETO products
5. Work Tasks
   - Standardization work group
   - API & IT infrastructure

# Identified Challenges in Information Flow in the Construction Industry

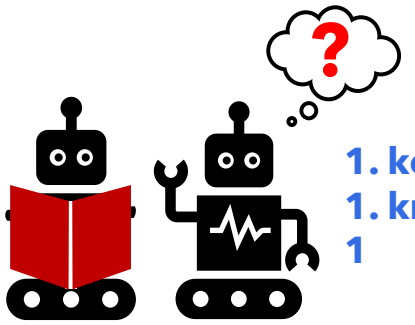

**Manual Processing of Unstructured Information** (e.g., PDF, PNG, email, phone calls)
Requires human interpretation and inefficient manual work, increasing the risk of errors as the same information is repeatedly generated, stored, lost, and archived.



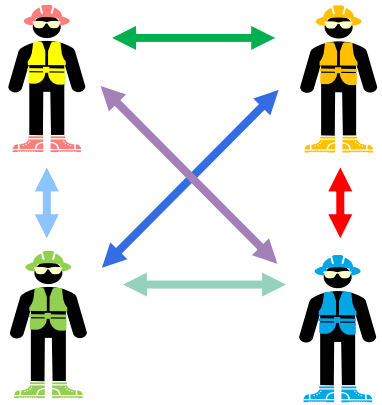

**Silo thinking** fragments workflows, weakens communication, and reduces efficiency when stakeholders define matters separately without collaboration.



**Lack of standardization and interoperability** in information management processes prevents industry development.



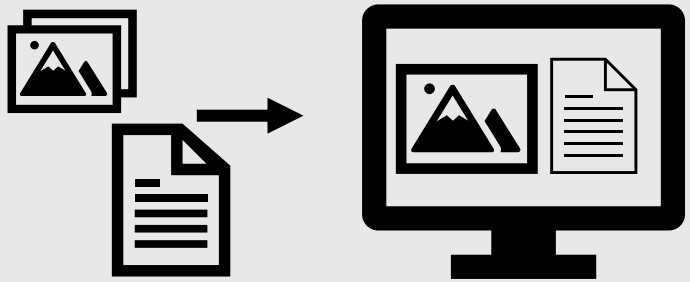

**The lack of machine-readable structured information** prevents the automation of processes in the construction industry.



**Closed Information Exchange Solutions Between Stakeholders**
Point-to-point solutions operating in a closed environment are inefficient and costly, as each system pair requires a separate solution

# Are we aiming for digitization or digitalization?

**Digitization**

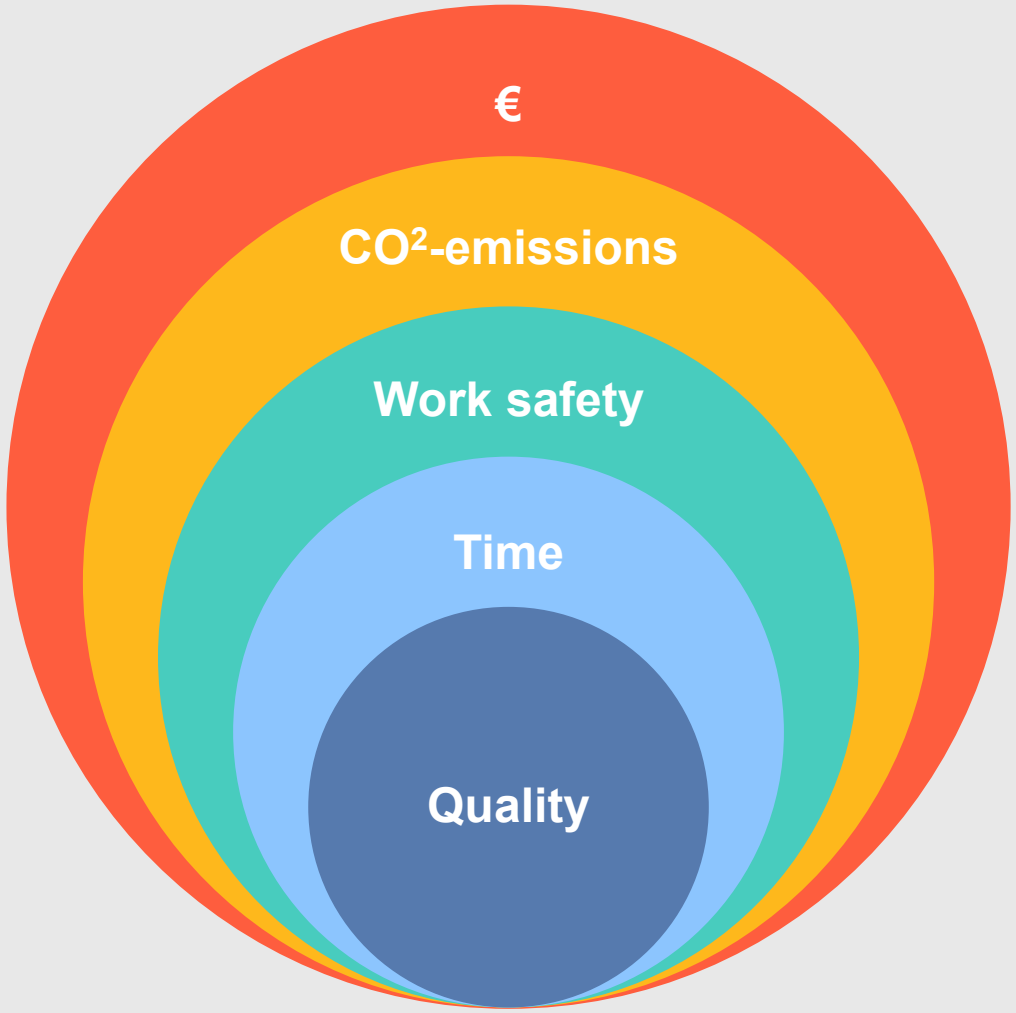


- Converting information into a digital "image" of the data.
  - Converting native software files (Word, Excel, etc.) into digital "images," such as PDFs
  - Converting native BIM into IFC without machine-readable standardization of data content.
- The data is not machine-readable and requires human intervention

**Digitalisation**

- Transforming data into a structured format so that it can be transferred automatically and seamlessly between systems
- Requires the definition of metadata.
- The goal is to create new ways to use, analyze, and manage data more efficiently

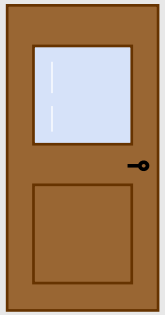
# Why should we strive for digital supply chain management?



# Contents

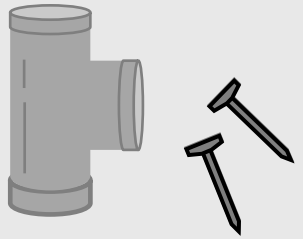
# PRODUCTION STRATEGIES FOR BUILDING PRODUCTS

Engineer-To-Order



Make-To-Order

Assemble-To-Order



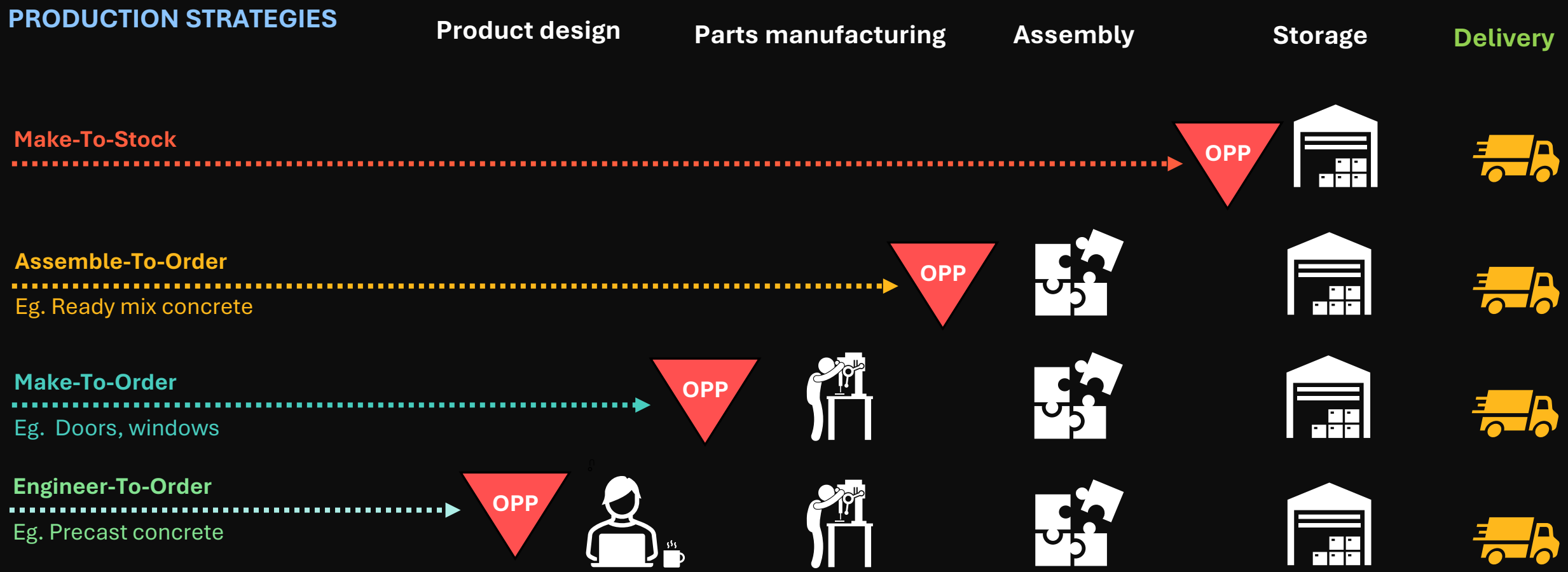
Make-To-Stock

PROJECT-SPECIFIC PRODUCTS

OFF-THE-SELF PRODUCTS

# Different production strategies for building products delivered to the site

*A challenge for the procurement process, production planning, and design that has neither been identified nor solved from the perspective of information management.*




*Order Penetration Point (OPP), where push control transitions to pull control.*

source: https://www.logistiikanmaailma.fi/tuotanto/tilauksen-kohdennuspiste-opp/

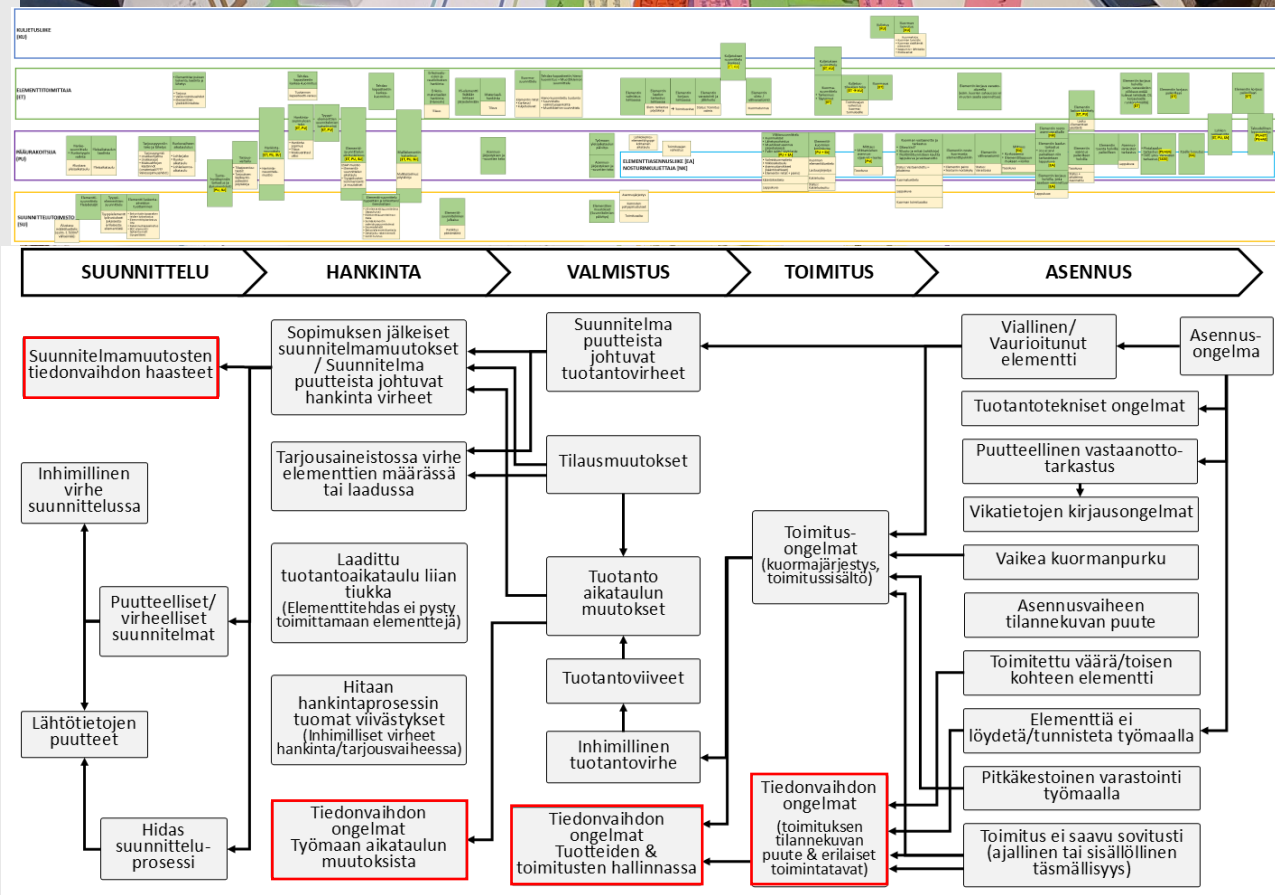
# Preliminary study on the current state of the ETO Supply Chain

The BETK project was initiated through supply chain workshops consisting of experts, aiming to map the current process of the precast concrete element (sandwich + partition wall) supply chain, covering all stages from design to installation, and to identify issues occurring in different parts of the supply chain.

In these workshops, each stage of the process was analyzed, including the involved stakeholders, current information exchange methods and formats, as well as encountered challenges.

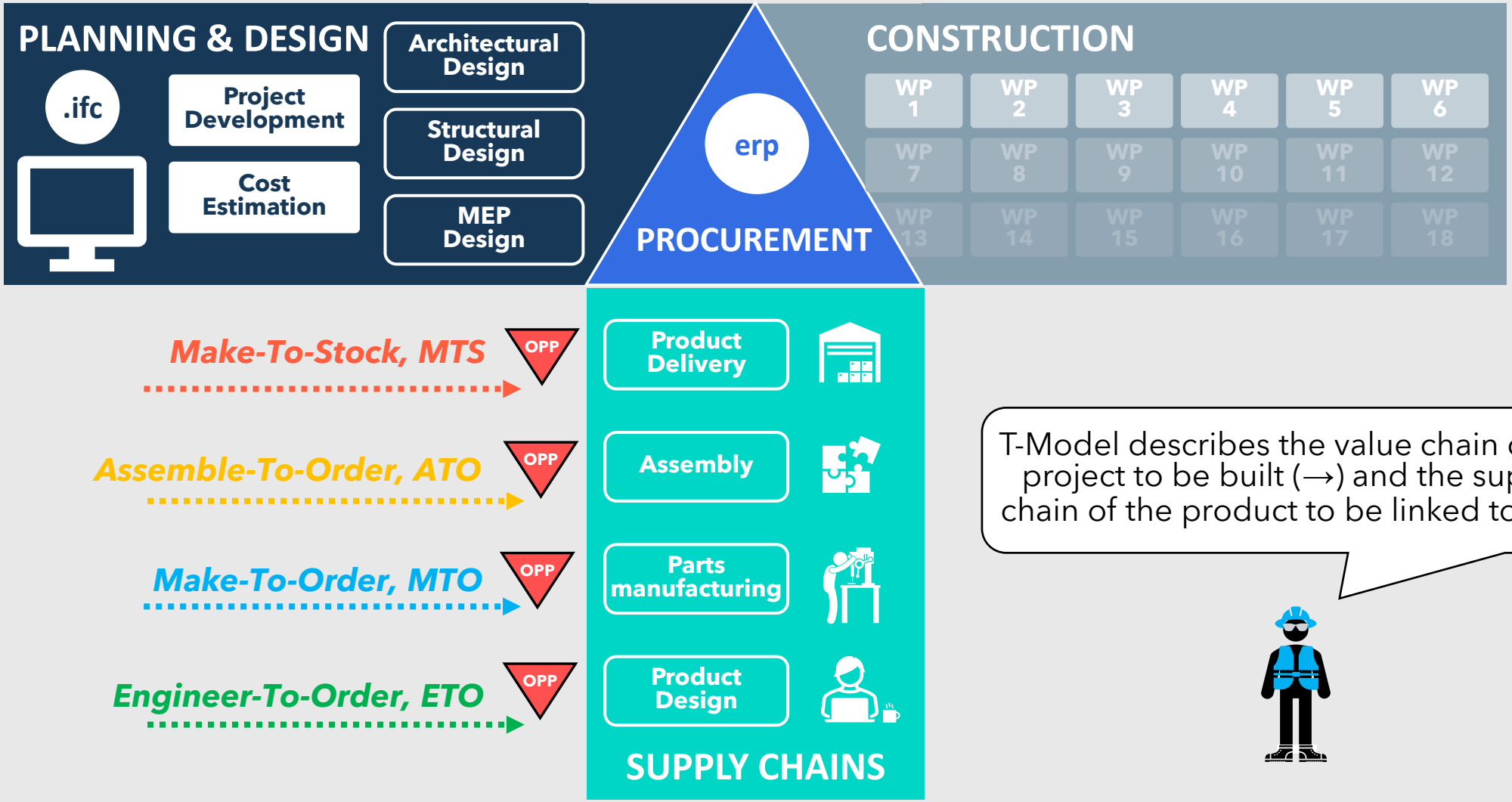
The key findings were related to information flow between different phases of the supply chain.

*Reference: Alaluusua, T. (2023) Digital management of information exchange in takt production supply chains*



# Towards (true) Supply Chain Management

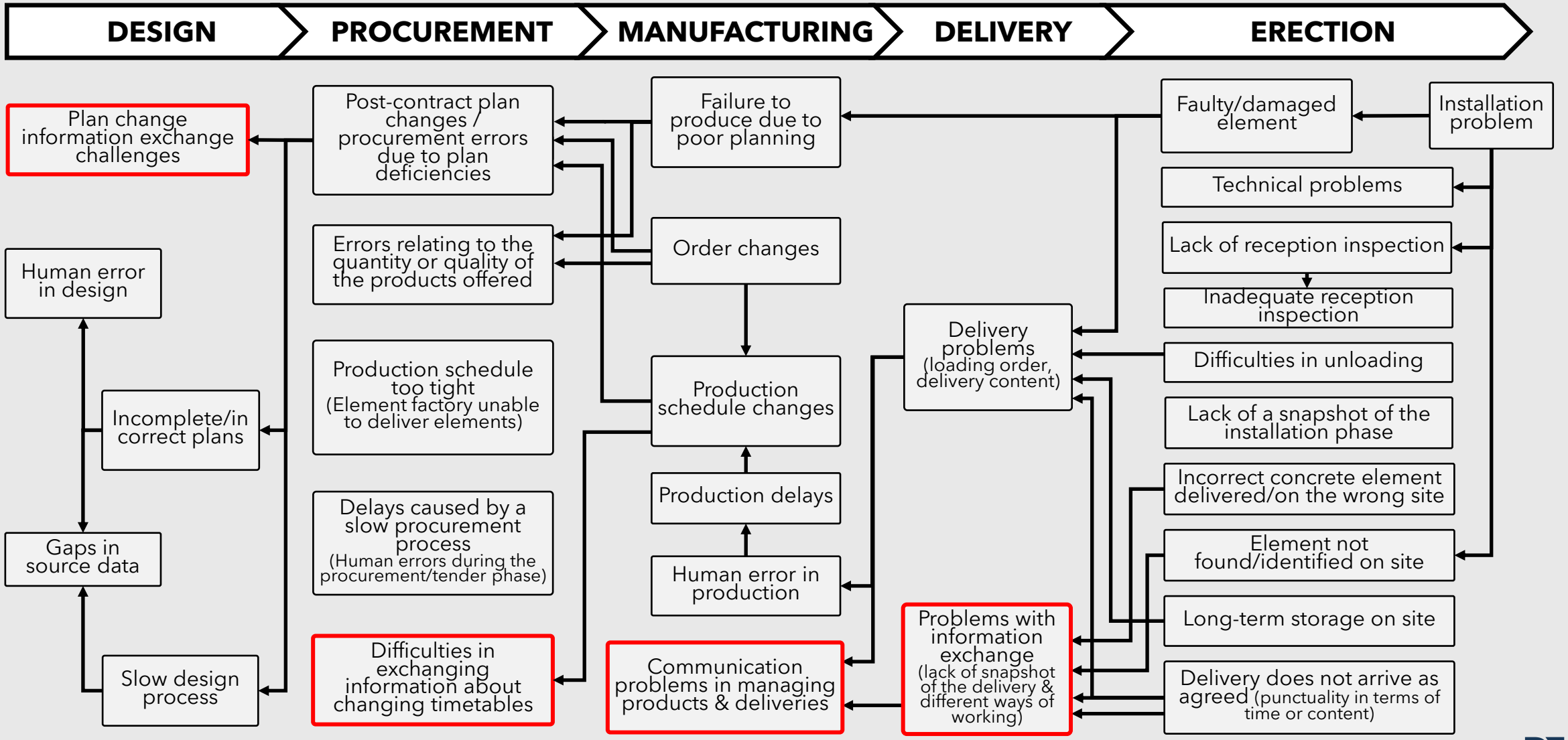



T-Model describes the value chain of the project to be built (→) and the supply chain of the product to be linked to it (↑)

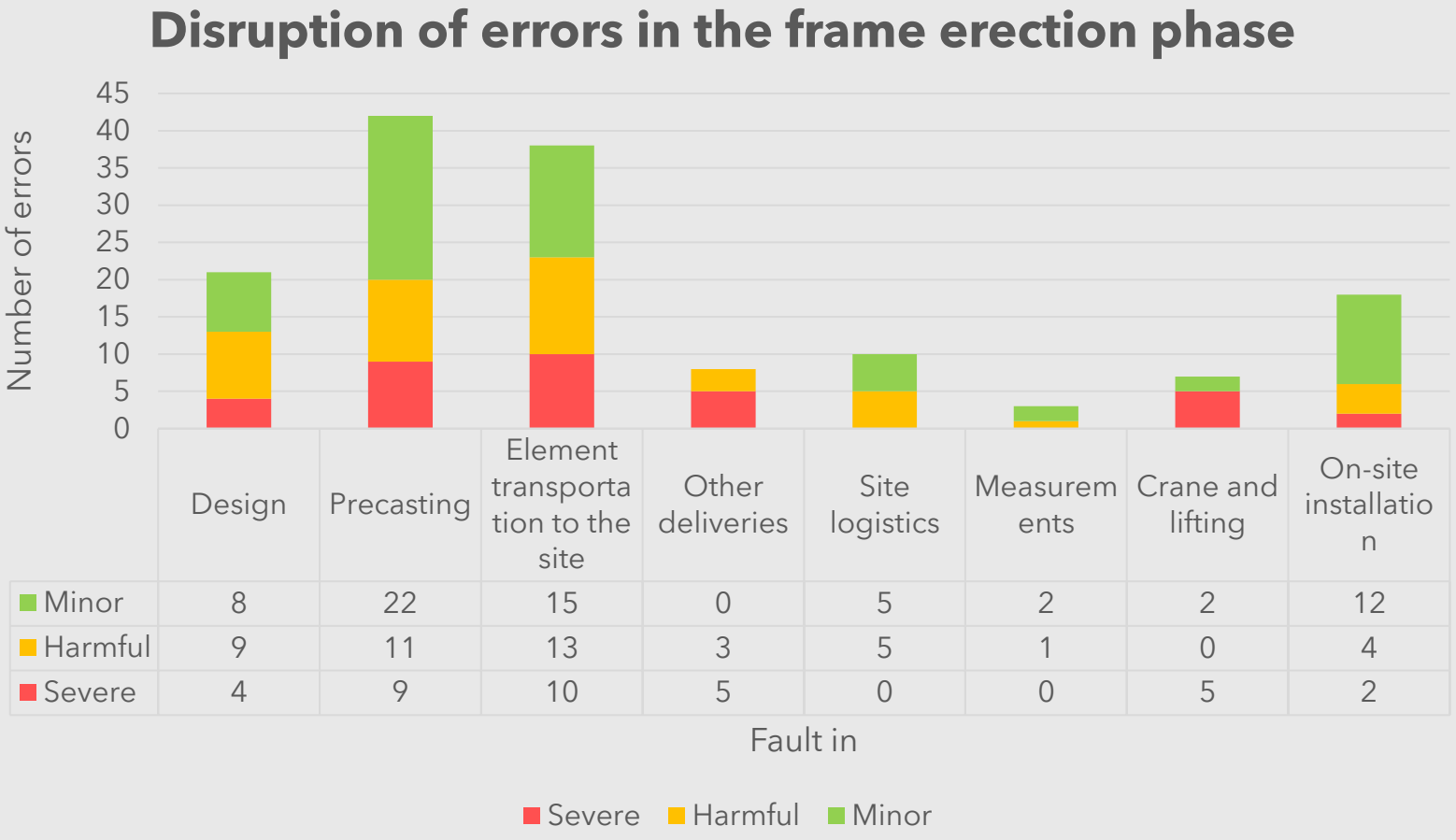


*OPP = Order Penetration Point*

# CAUSE MAP BASED ON WORKSHOP RCA



# Preliminary Study on the Current State




| | Design | Precasting | Element transportation to the site | Other deliveries | Site logistics | Measurements | Crane and lifting | On-site installation |
|---|---|---|---|---|---|---|---|---|
| Minor | 8 | 22 | 15 | 0 | 5 | 2 | 2 | 12 |
| Harmful | 9 | 11 | 13 | 3 | 5 | 1 | 0 | 4 |
| Severe | 4 | 9 | 10 | 5 | 0 | 0 | 5 | 2 |

Measurements on four different sites

Measurement period: 50 total workdays

**Minor Disruption**
Work becomes slightly more challenging or slows down a bit. Disruption duration is often less than 30 minutes.

**Harmful Disruption**
Work slows down significantly or requires expensive measures. Disruption duration over 30 minutes.

**Severe Disruption**
Work becomes slightly more challenging or slows down a bit. Disruption duration is often less than 30 minutes

*Reference: Makkonen, S. (2023) Improving process flow in frame erection phase of a residential building*

# Example problems

## DESIGN

**MALLIPUU**

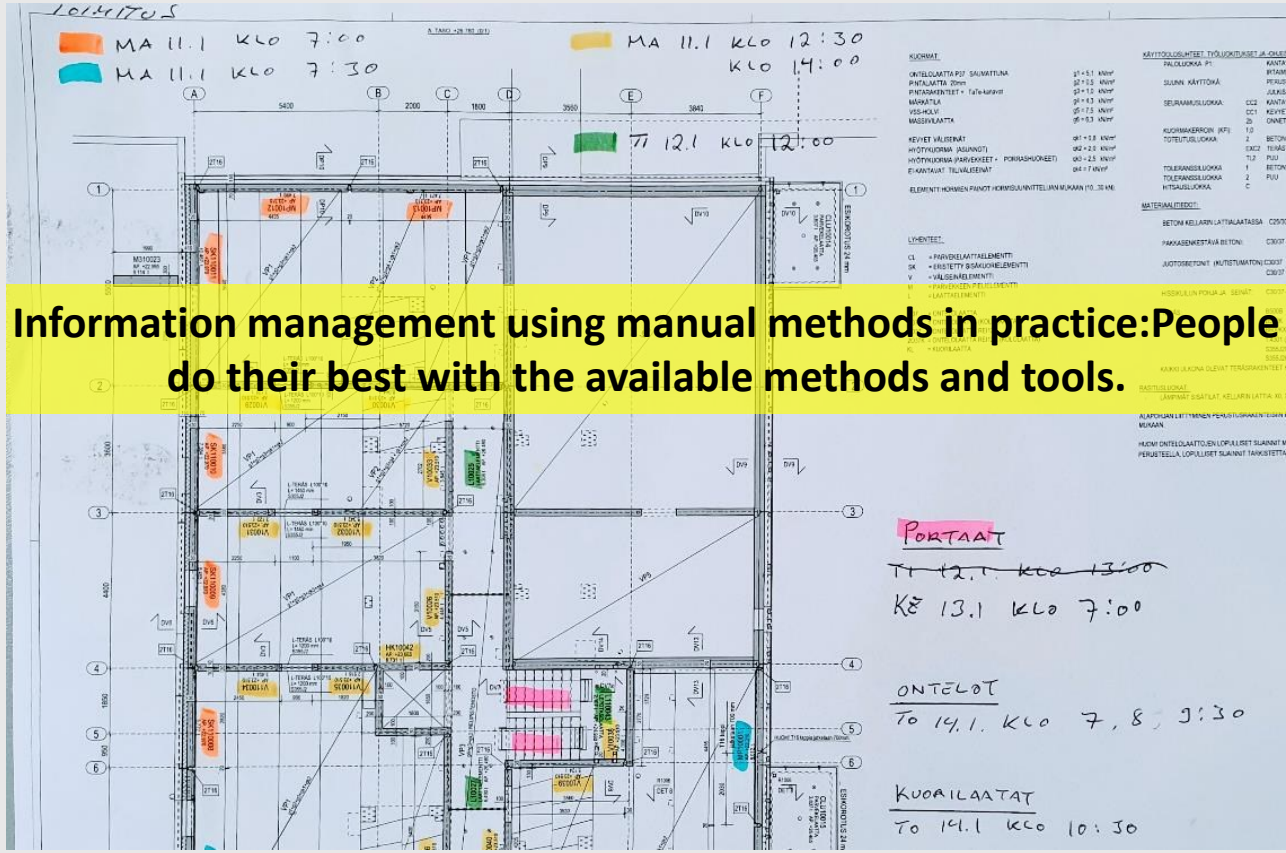
- (B) LVI KOHDE X
  - (B) Tontti.1
    - (B) mc-building
      - (B) Ryomintatila
      - (B) 1. kerros
      - (B) 2. kerros
      - (B) 3. kerros
- (C) RAK KOHDE X
  - (C) KOHDE X
    - (C) Rakennus.r.1
      - (C) 0
      - (C) 1
      - (C) 2
      - (C) Kerros. 3

The same building, but different designers use different naming conventions for identifying floors.

[number]. Floor
[number]
Floor. [number]

A human can resolve this by reasoning, but a machine cannot. Automated data transfer is not possible with such information.

## INSTALLING




**Information management using manual methods in practice:People do their best with the available methods and tools.**

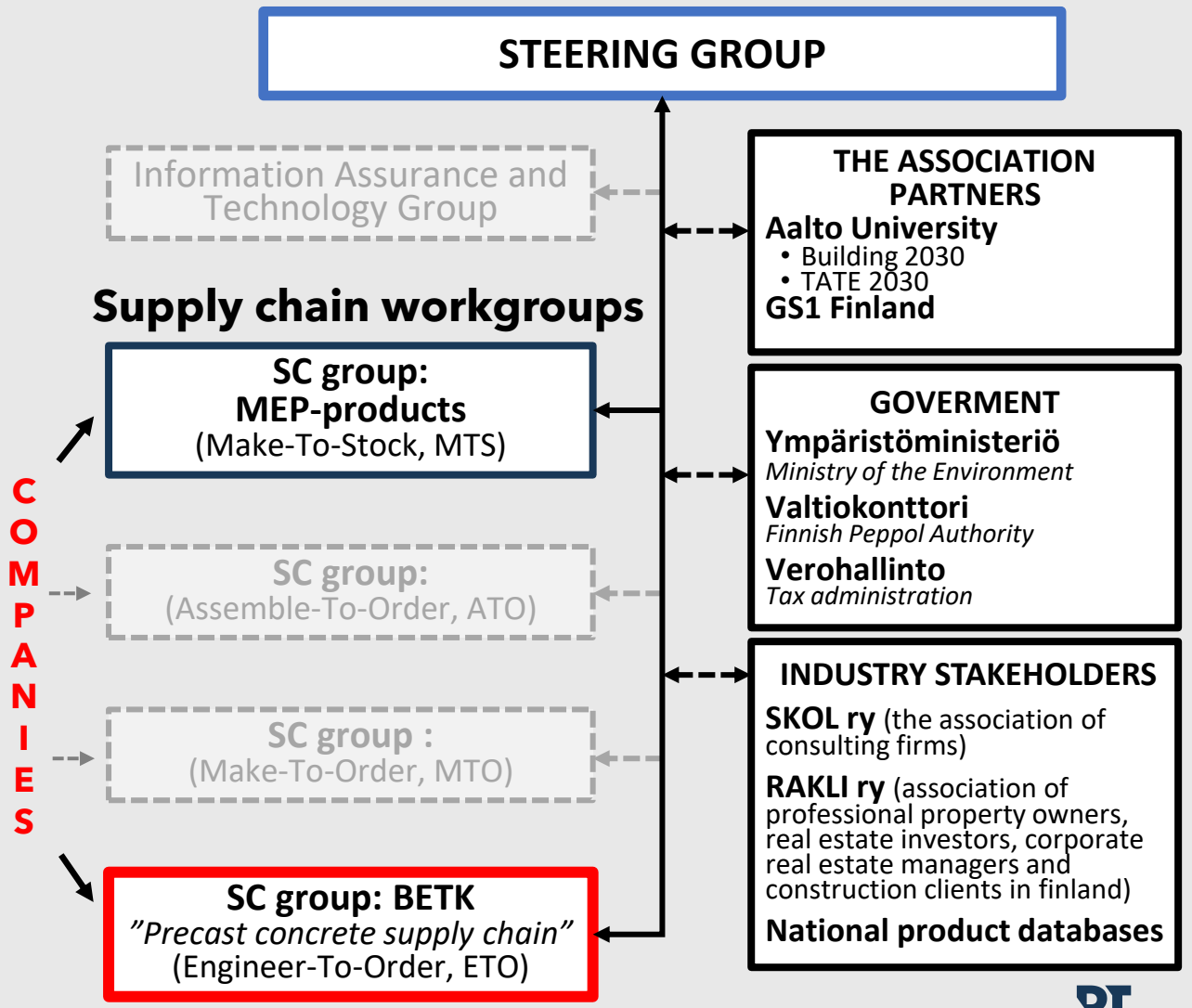
# Contents

# Project organisation

The Confederation of Finnish Construction Industries (RT) is currently running a development project focused on digitalizing product information and supply chain management in construction. A steering group guides the development, and its members vary according to the supply chain groups.

The development work is carried out in supply chain work groups, which are divided according to the production methods (**MTS, ATO, MTO, ETO**).

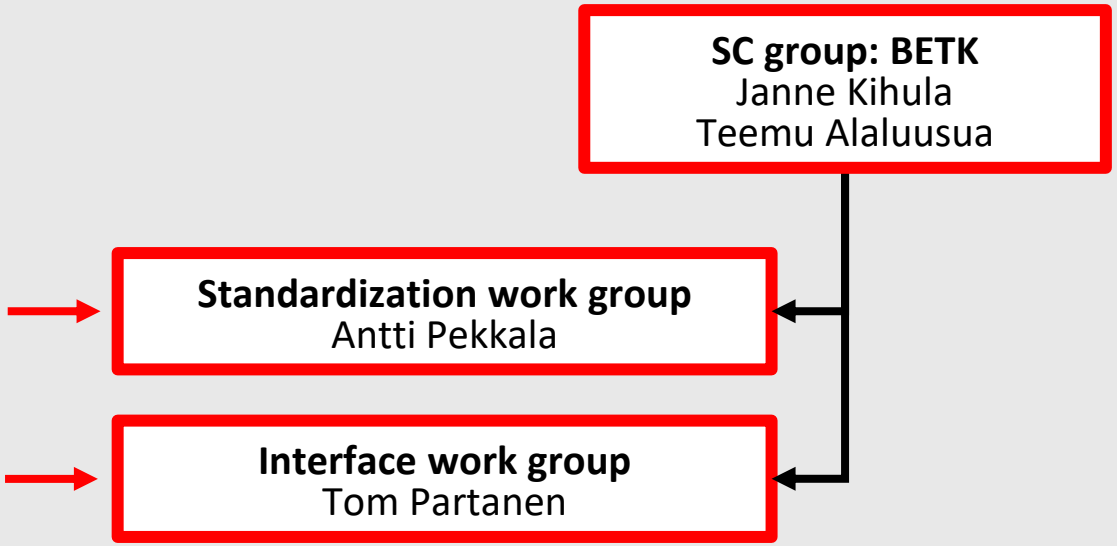
The working groups are composed of construction companies, associations, supply chain experts, academics and public sector actors. The project aims at an integrated and digital information management to improve the efficiency and transparency of supply chains.



# SC group: BETK

BETK is part of the Confederation of Finnish Construction Industries RT's development project for the digitalization of product information and the supply chain. Its goal is to digitalize the supply chain of engineer-to-order building products.

The BETK working group is divided into two subgroups, focusing on data standardization and data transfer interfaces.

# Contents

# Product Information and Supply Chain Digitalisation Development project
## BETK-Supply Chain group

## OBJECTIVE

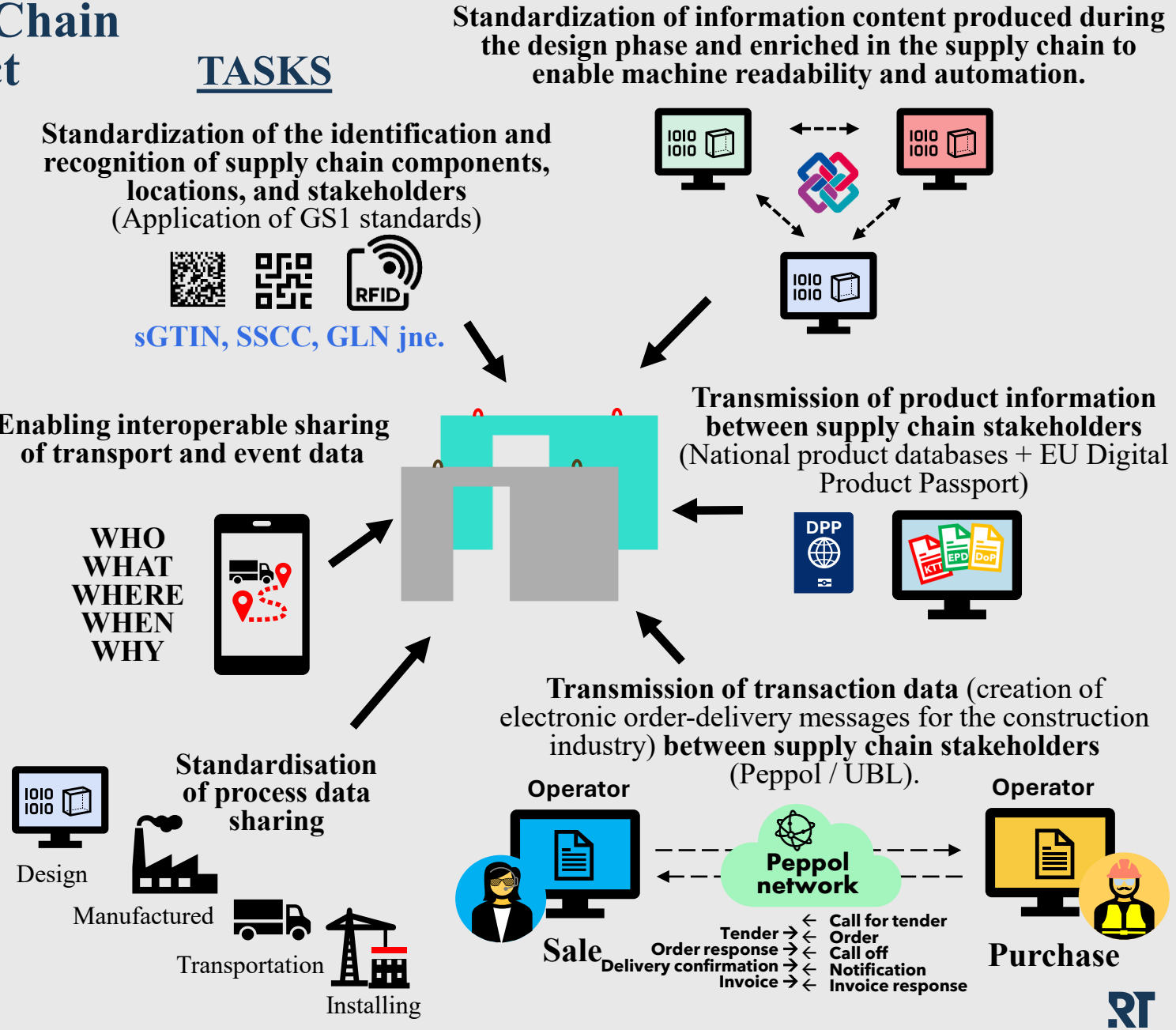
Enabling interoperable and digitally managed data transfer in the supply chains of order-based designed building products:

- Exchange of machine-readable information
- Standardized data content
- Uniform methods for information identification, recognition, and sharing processes
- Availability of product data and recording of process data in the supply chai

## PARTICIPANTS

- Construction industry companies
- Data transfer expert companies
- Academia
- Public sector representatieves
- Non-profit organizations

## TASKS

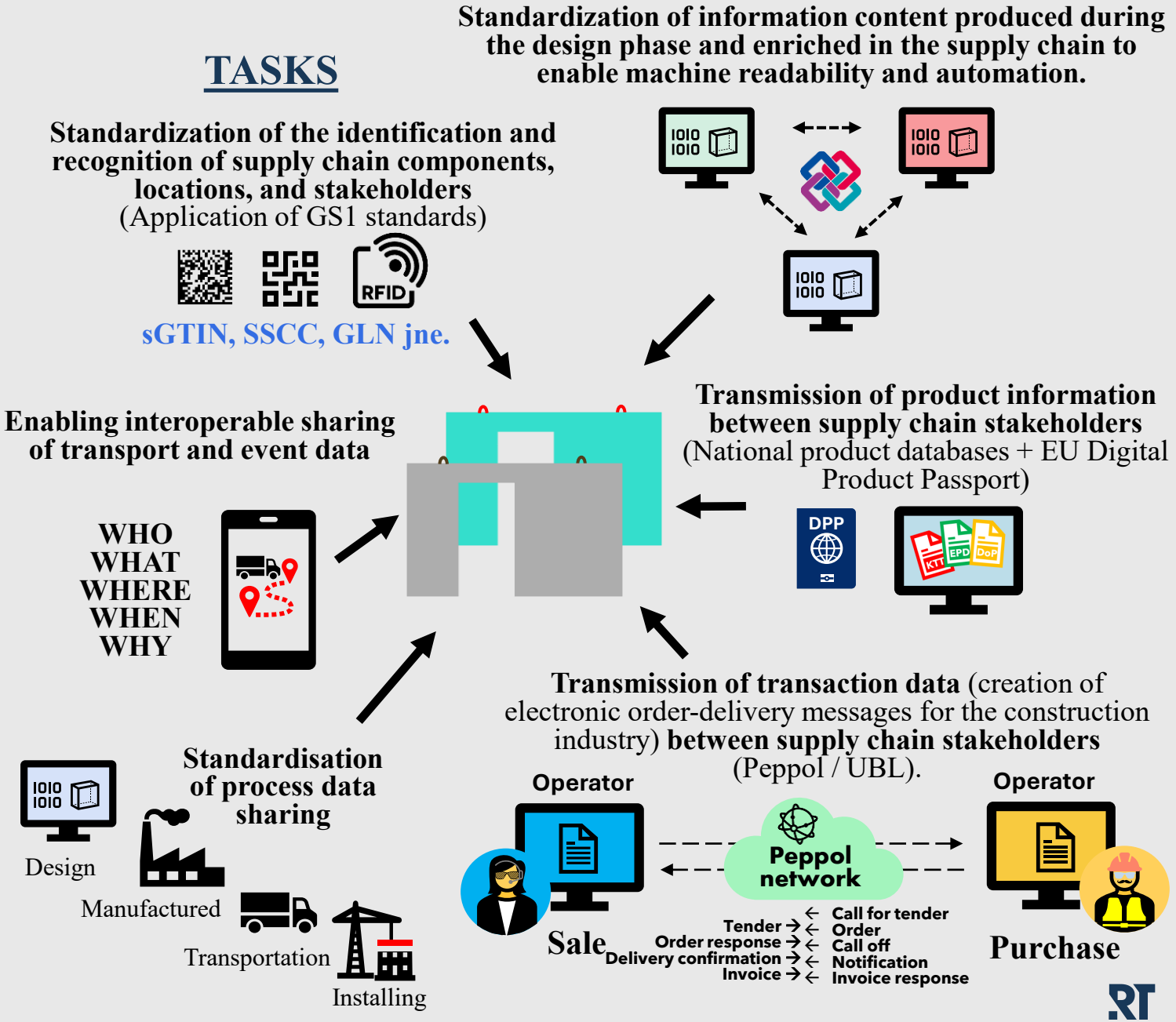


# Work Tasks

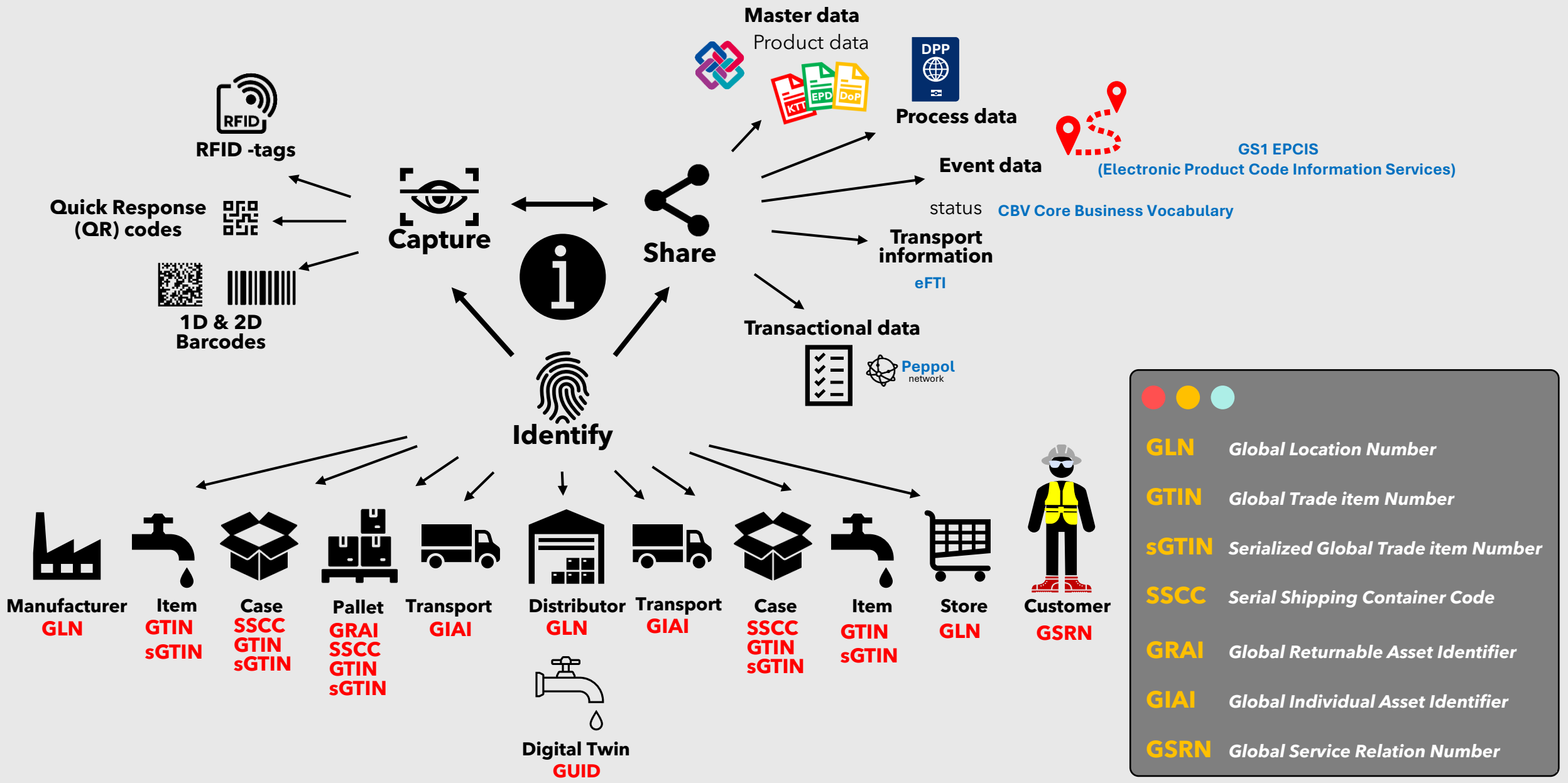
BETK develops and standardises solutions to support the flow of information and develops application guidelines for the construction sector.

The task of the working group is to promote the interoperability of information flows in accordance with the production strategy for custom-designed construction products and to promote the development of the industry through standardisation.

The BETK working group is divided into two working groups on information standardisation and interfaces for information transfer.



# Key factors to enable digital supply chain management interoperability



# Roadmap for the digitalisation of construction supply chains *(ETO-products)*

**Digitalisation 2.0:**
Digitalisation of responsible construction and the use of modern technology

**Digitalisation 1.0:**
Digitising current construction processes

Automated GWP and sustainability reporting

Implementing circular economy processes

Monitoring the carbon footprint of building design

Automatic calculation of the actual carbon footprint

As-built data collection and digital delivery

Adoption of AI-based processes

Digital takt-production management

E-supply chain management

Design and product information digitally into procurement systems (ERP)

Message based order-delivery process
(PEPPOL / EPCIS / eFTI)

(BIM) export to structural form
(E-BOM → M-BOM)

Product data sharing
(ETIM, TT-standard)

EU DPP
(2027)

Reference data for for design
(data dictionaries)

UPID
**Product Identification**
sGTIN

AIDC
**Data Carriers**
(2D codes / RFID)

**Strategic objective**

**Digitalised way of working in construction**

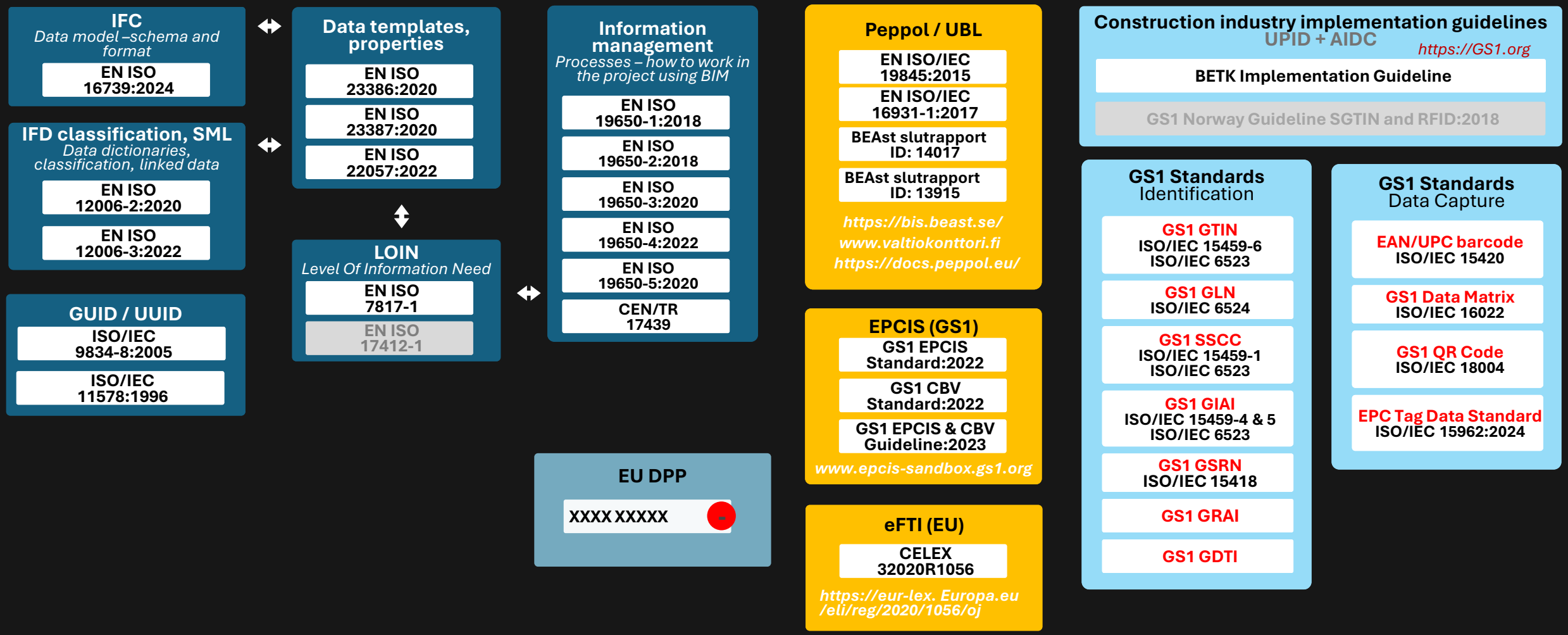
**Order-delivery process**

**The procurement process:**
Company's own ERP/data platform

**Product data process:**
GS1 standards

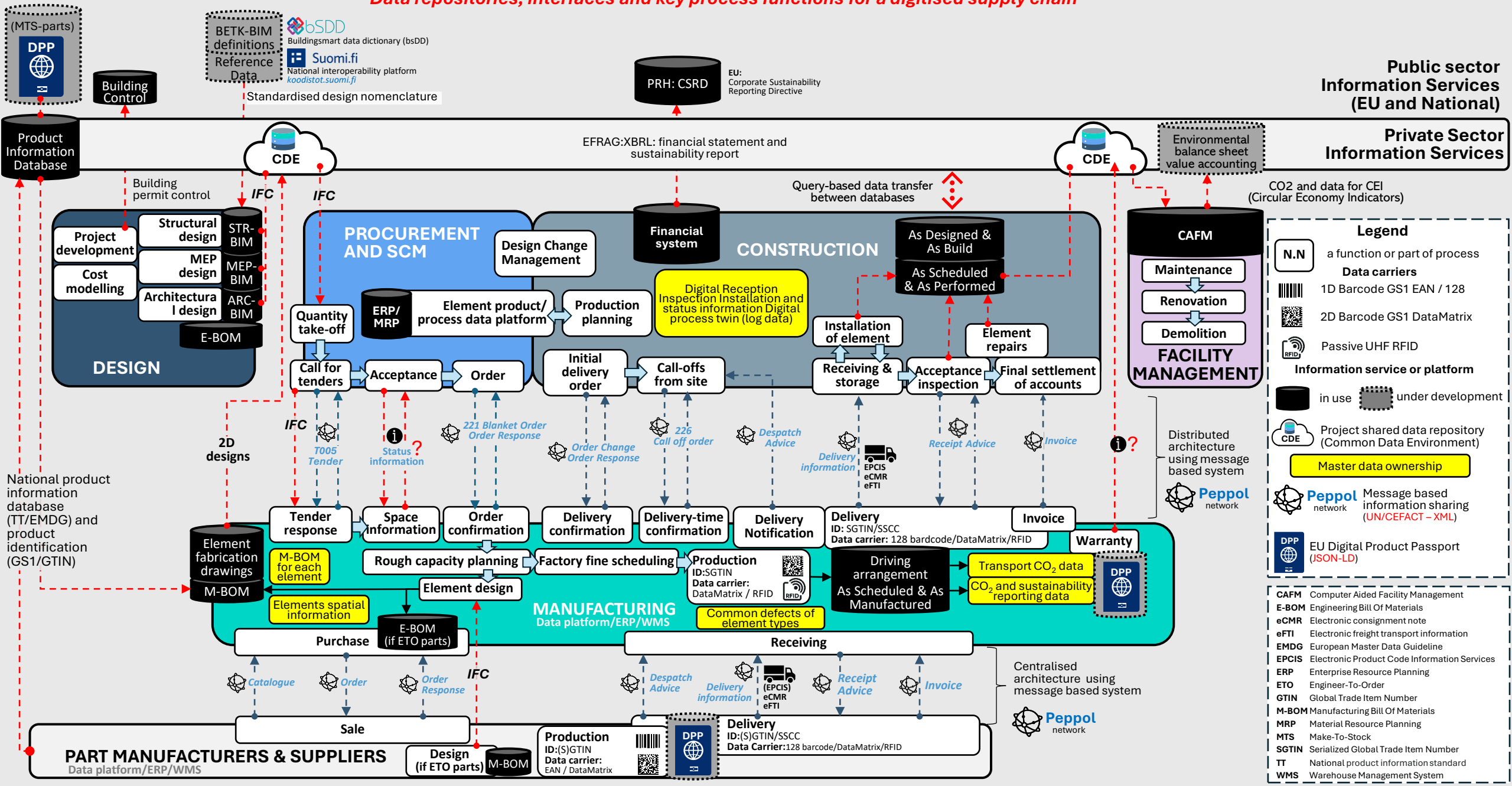
**Design process:**
Data dictionaries, reference data

# Standards that make systemic change possible



# Future state Data Flow Architecture for an ETO construction product from design to finished building

***Data repositories, interfaces and key process functions for a digitised supply chain***



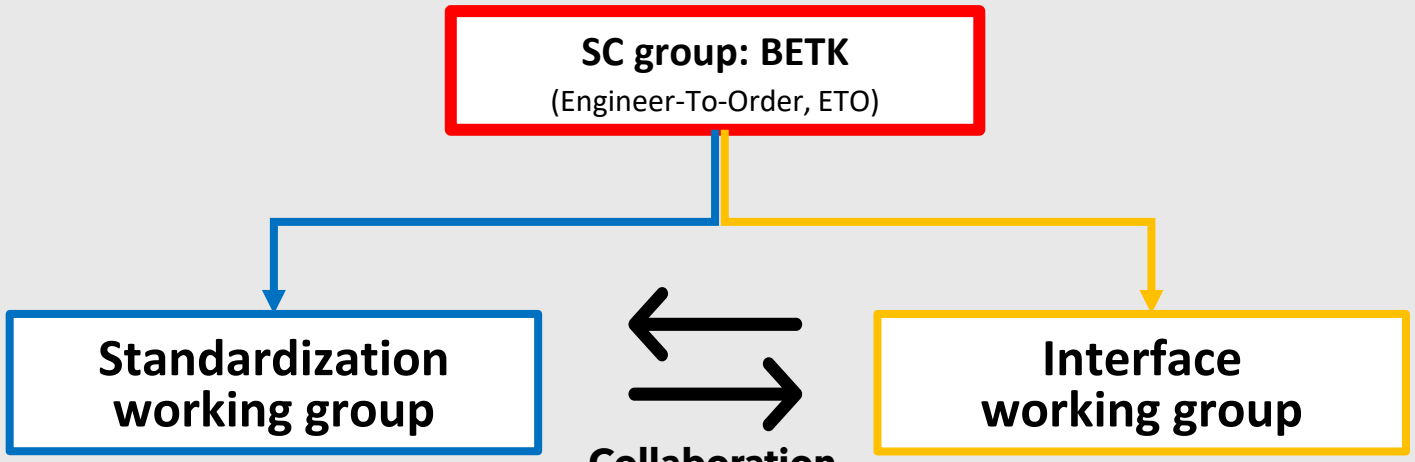
# Contents

1. Motivation
2. Background
   - Manufacturing strategies
   - T-Model
   - Preliminary study on the current state of the ETO Supply Chain
3. Project Organization
4. Work Objective
   - Road-map
   - Future State Data Flow Architecture for an ETO products
5. Work Tasks
   - Standardization work group
   - API & IT infrastructure

# Work tasks

The BETK working group develops and standardizes solutions that support the flow of information and prepares application guidelines for the construction industry.

The BETK working group is divided into two subgroups that focus on data standardization and data transfer interfaces.




The main focus is on identifying and standardizing common industry practices.

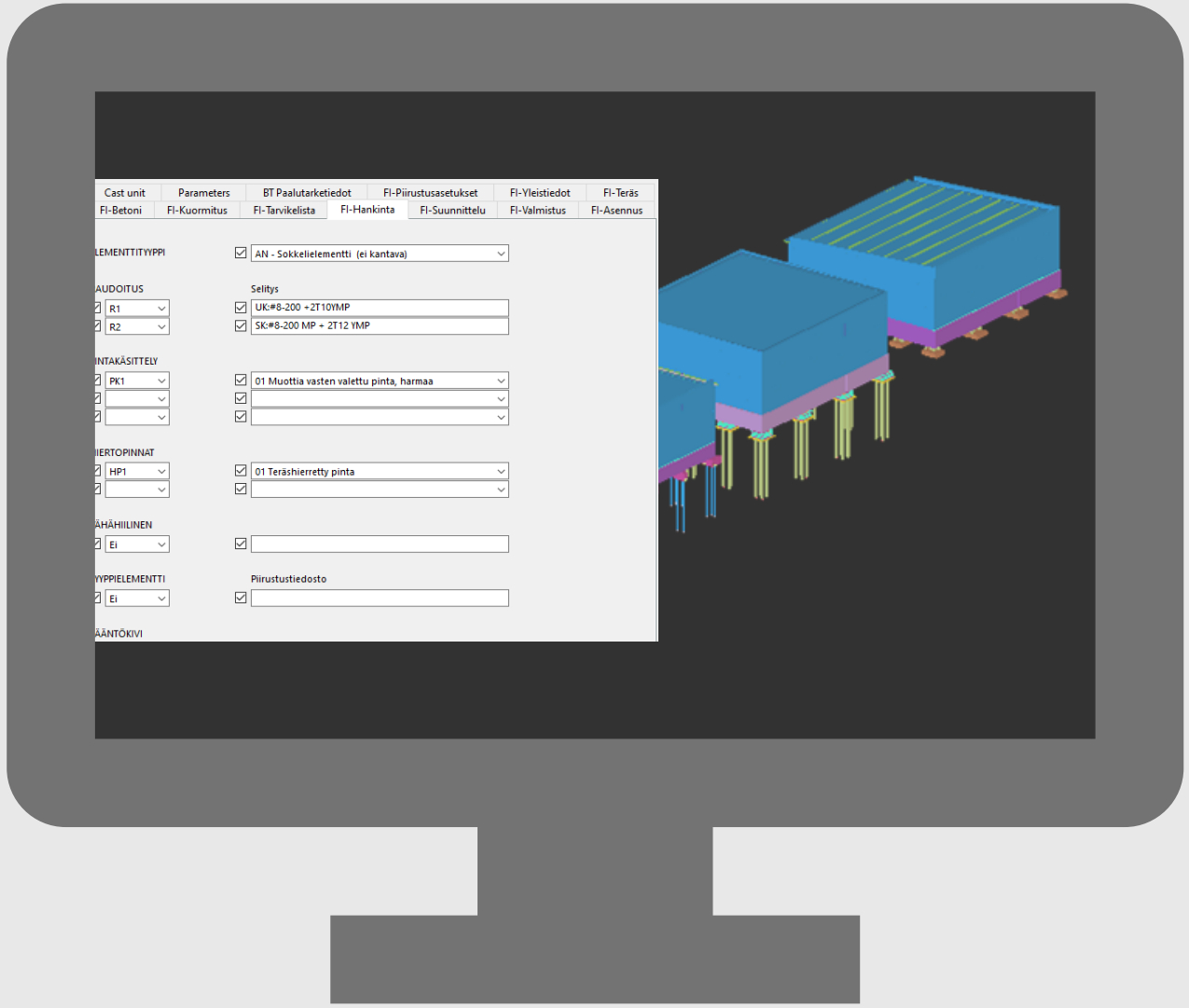
- Standardization of BIM modeling requirements
- Process data definitions
- Supply chain statuses
- etc.

The main focus is on producing application guidelines for transferring supply chain-related data.

- Peppol (transaction data)
- EPCIS (event data)
- eFTI (transport data)
- EU DPP
- etc.

# STANDARDIZATION working group

The task of the Standardization Working Group is to develop software-independent solutions that enable the automated generation and enrichment of standardized, machine-readable information at different stages of the supply chain.




# STANDARDIZATION
## working group

The BETK working group defines the product and process information content for the precast concrete supply chain using interoperability platforms (**buildingSmart Data Dictionary & koodistot.suomi.fi**).

The purpose of this is to establish and maintain the semantic interoperability of information shared within the precast concrete supply chain, ensuring that the meaning of data remains consistent across information flows.

Instead of each organization independently defining the content of a concept and the related data, this description is created once on the interoperability platform. Other parties can then reference and apply this description.

Technically speaking, the vocabularies, code lists, and data model descriptions published on the interoperability platform are linked data, meaning they are uniquely identified web resources with permanent identifiers that can be referenced from elsewhere.

bSDD

DIGI- JA VÄESTÖTIETO-VIRASTO

**YHTEENTOIMIVUUSALUSTA**

- Koodistot-työkalu

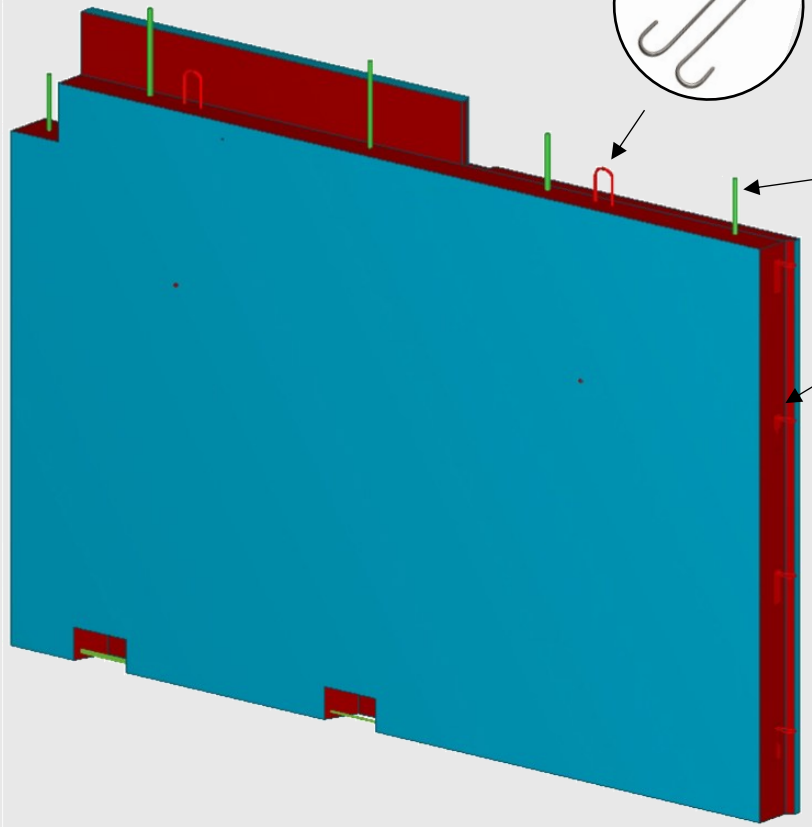
# STANDARDIZATION working group

RAKENNUSTIETO

TUOTETIETOKANTA

| METATIETO | |
|---|---|
| FI-Hankinta | |
| Elementtityyppi | ▼ |
| Raudoitus | V-Väliseinä |
| Pintakäsittely | VSP-Väliseinä (sei.. |
| Hiertopinnat | ..... |
| Vähähiilinen | |
| Status | |
| Paino | |
| Kerros | |
| Lohko | |

The standardization of design data enhances the machine readability of product metadata and facilitates the flow of information to the next stages of the supply chain





***Product:*** *Nostolenkki S235J2+N PN32*
***GTIN:***.....

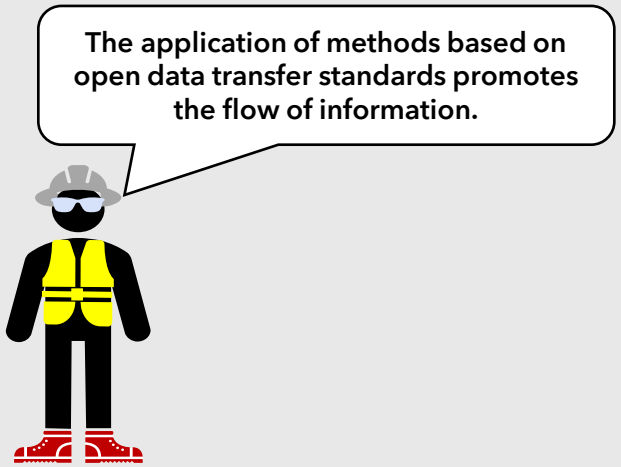
***Product:*** harvakierretanko
***GTIN:***.....

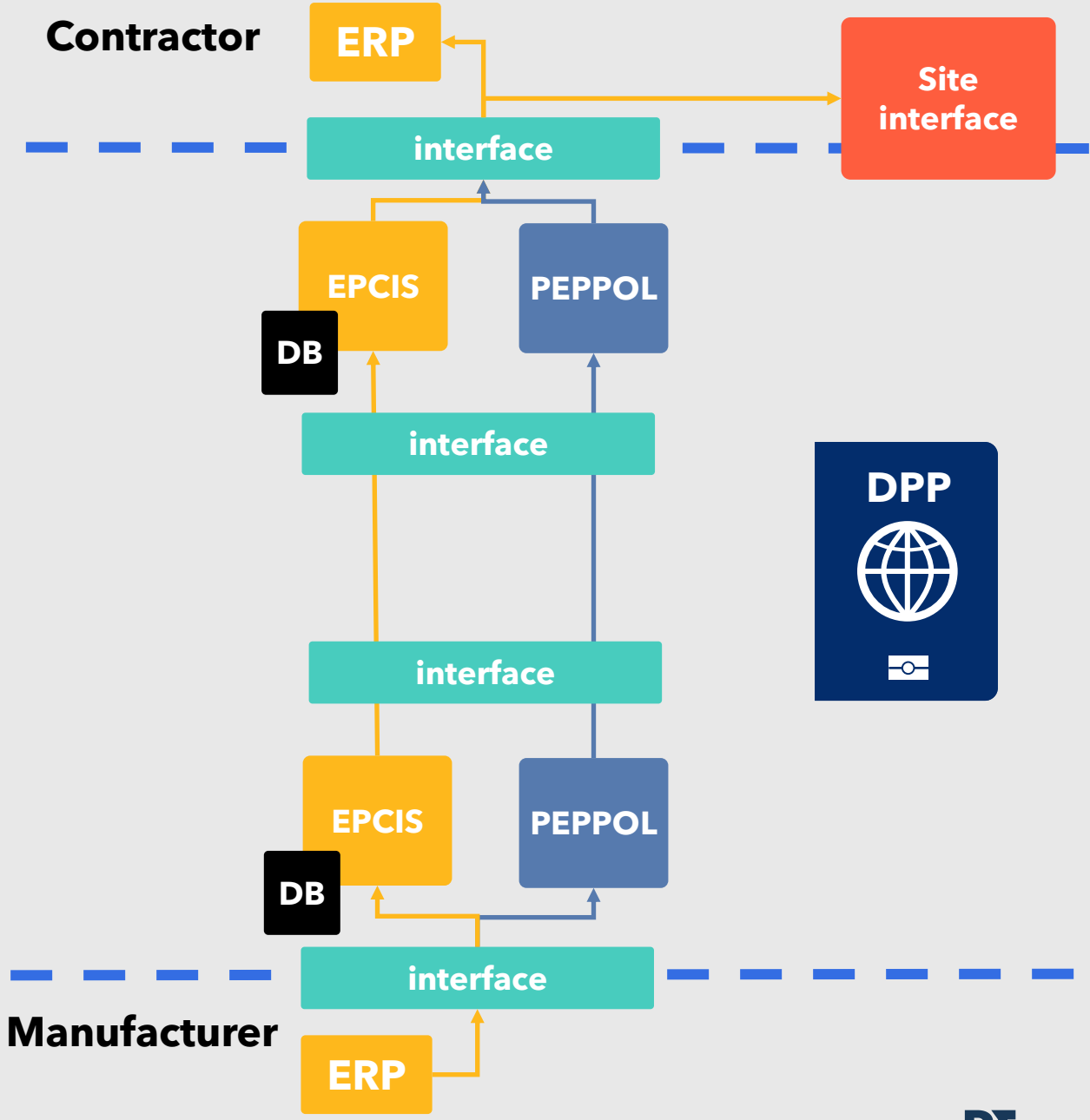
***Product:*** P-työsaumaraudoite
***GTIN:***.....

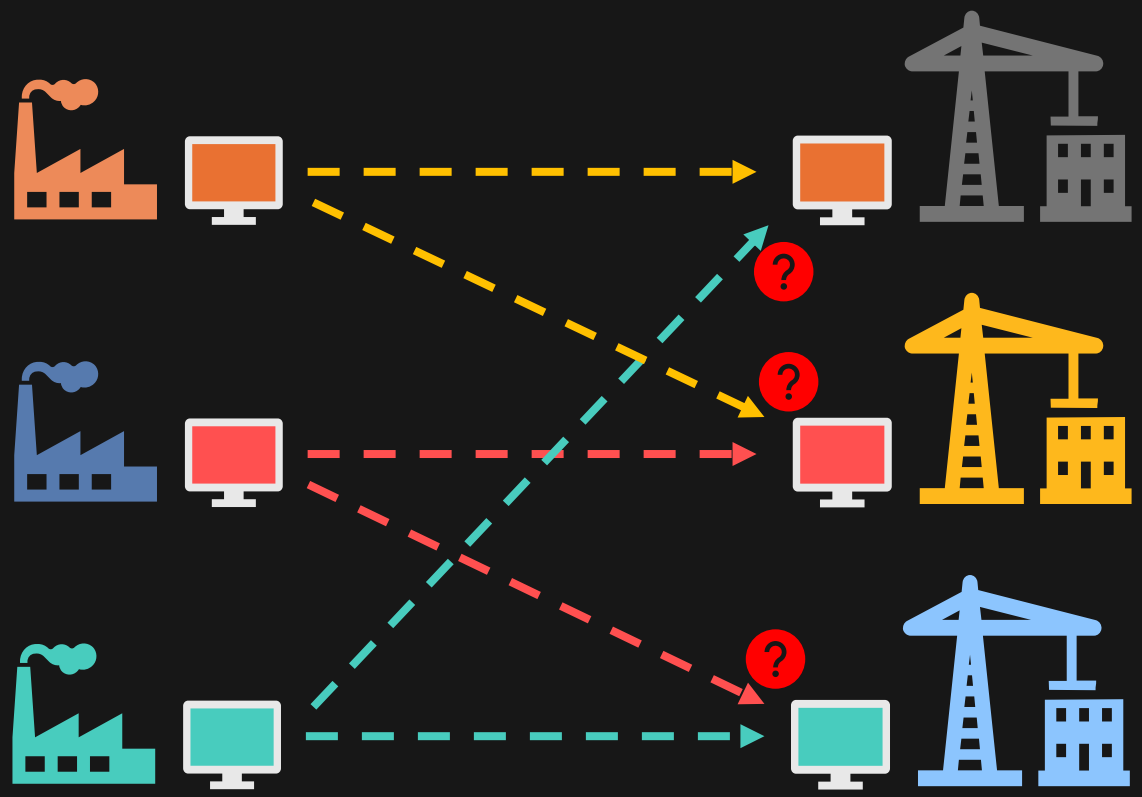
Did you know that the product database of Rakennustieto includes product information for casting accessories in a structural format compliant with the TT standard?

# INTERFACE working group

**The Interface Working Group** is responsible for producing application guidelines for the implementation of open data transfer solutions for construction industry stakeholders.
The group's goal is to create interface descriptions, taking cybersecurity into account, and outlining an exemplary architecture for the various parties in the supply chain.





A non-standard way to work


Standardised way to work

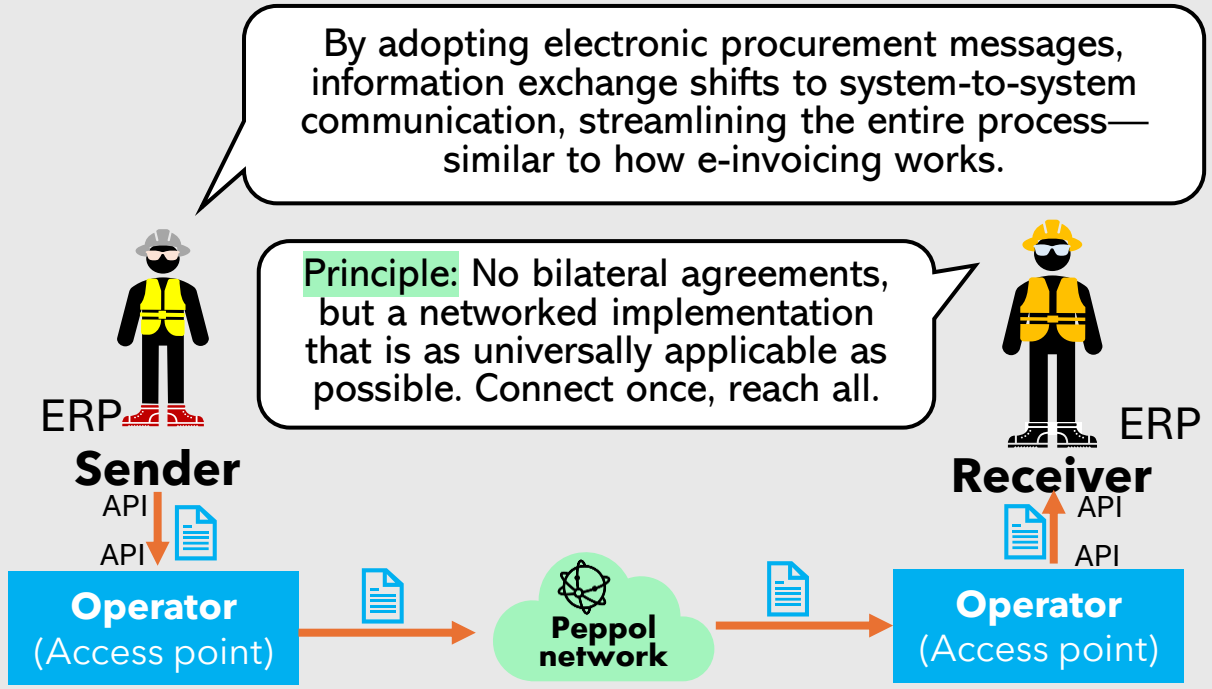
# INTERFACE working group

**Utilizing Peppol messages in the order-to-delivery process of construction products?**

- Peppol = a network, not a system
- Optimizing the supply chain, not a single point.
- Based on an international standard:
  ISO/IEC 19845: 2015
- Used in the construction industry in other Nordic countries.
- The State Treasury is the Peppol authority in

Peppol Authority

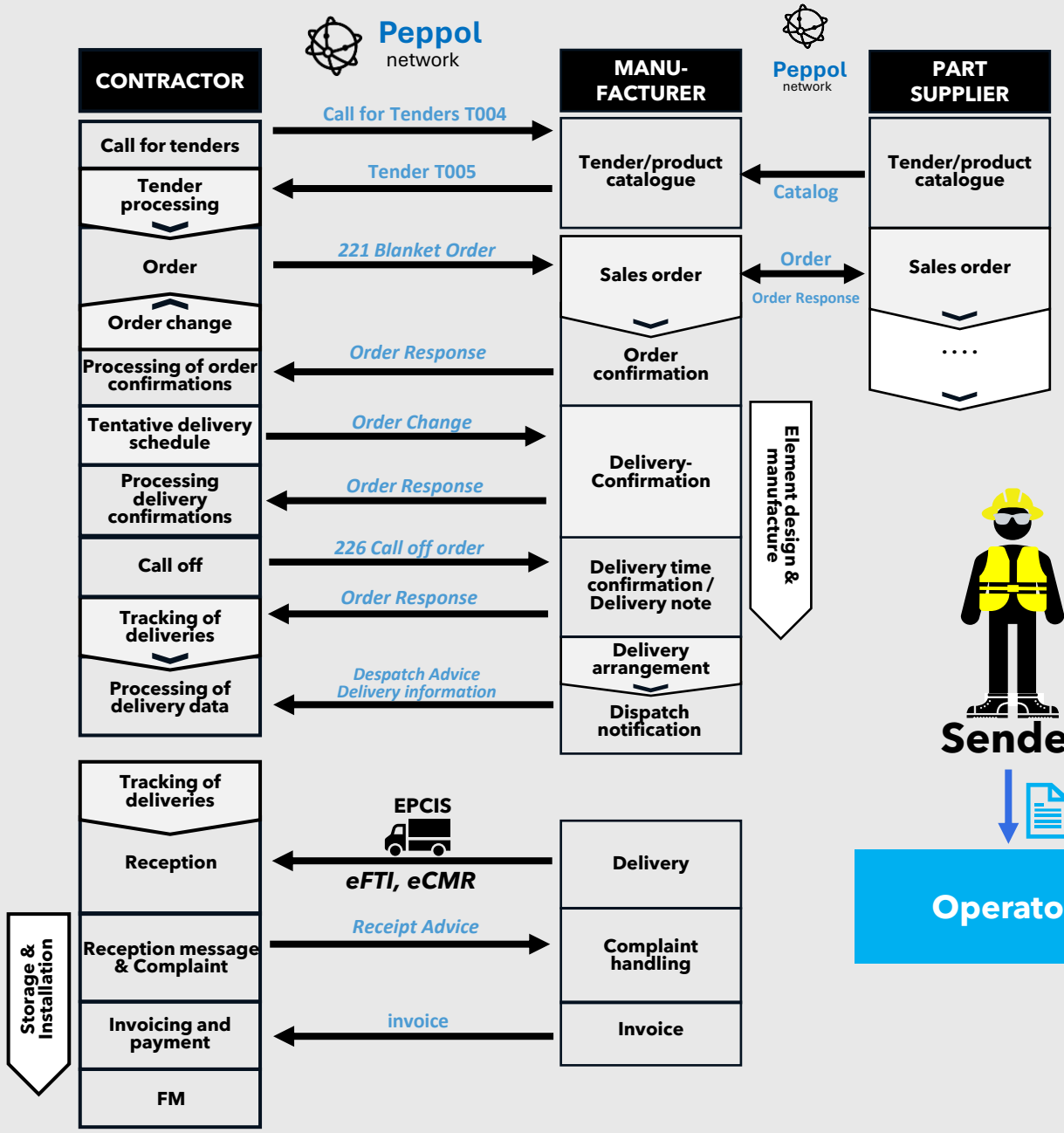
To connect to the Peppol network, a Peppol service provider and a compatible system (e.g., order management system, ERP system, etc.) are always required.



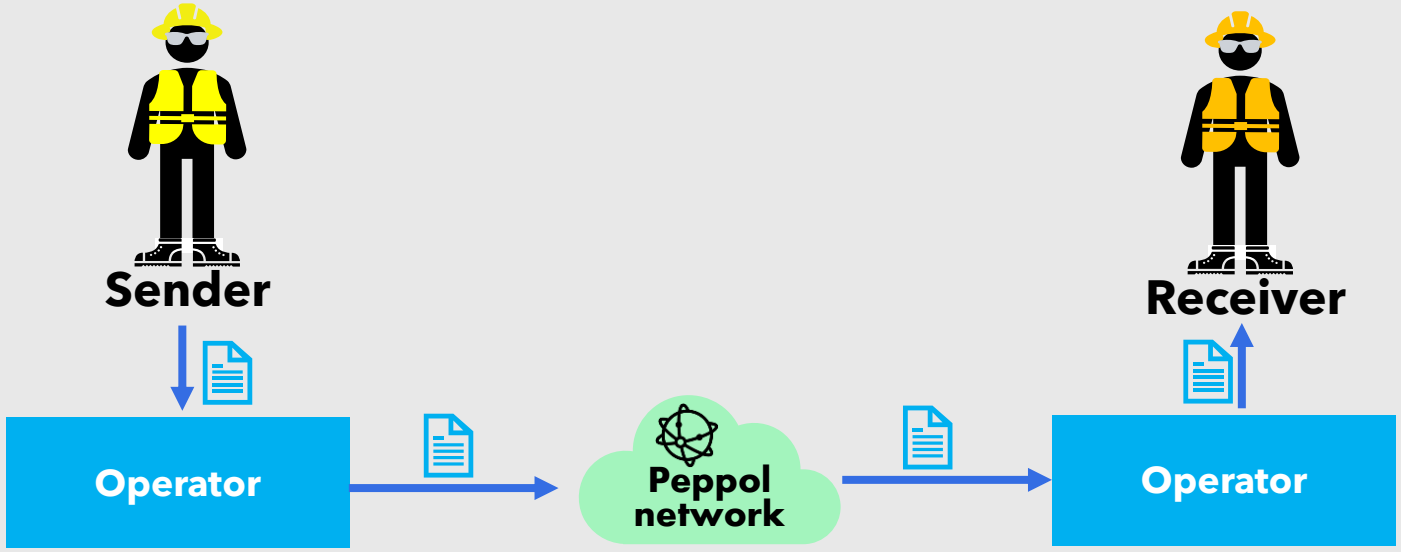

**More information:**

www.valtiokonttori.fi/peppol
www.valtiokonttori.fi/peppol-info
https://bis.beast.se/

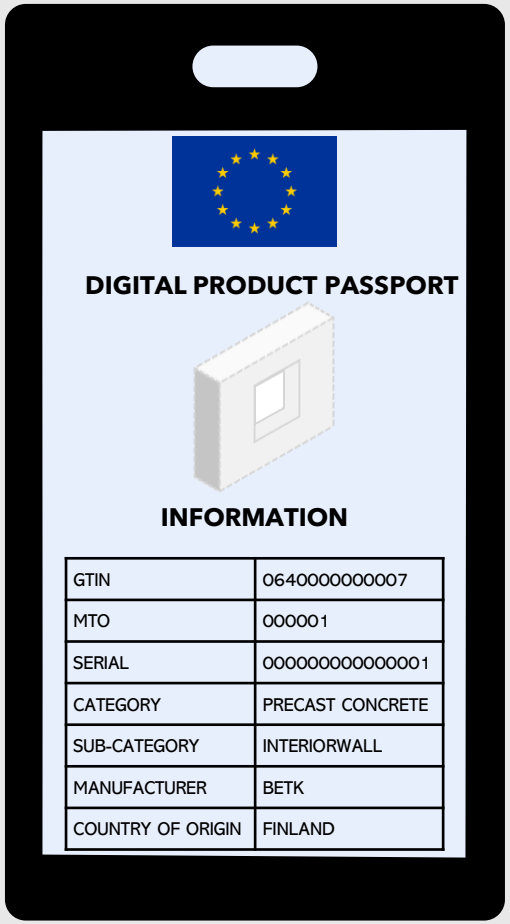
# Message based information sharing using Peppol-network




## Development project is currently focusing to define transactional information shared through supply chain



# INTERFACE working group





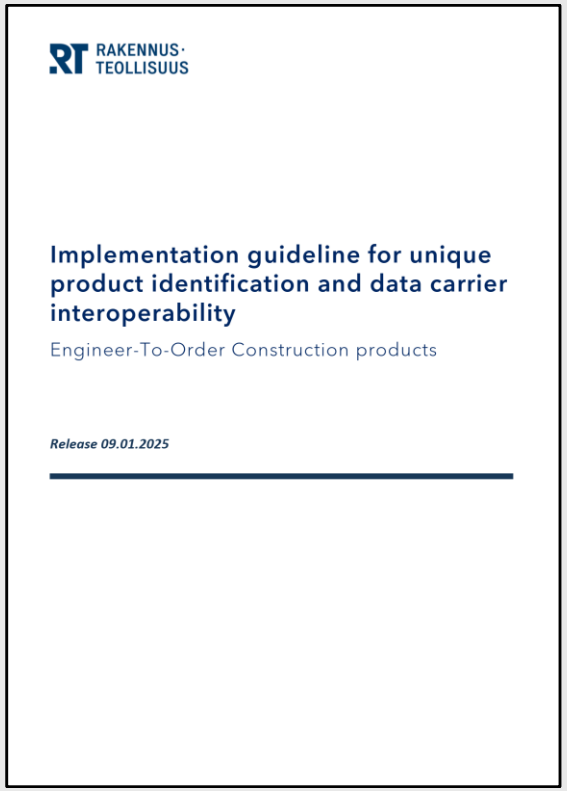
**GS1 Digital link**

Digital Product Passports (DPP) are set to revolutionize the construction industry by providing a standardized way to manage, enrich, and share information about construction products throughout the supply chain with producers, businesses, authorities, and consumers.

The BETK working group supports upcoming EU legislation by producing application guidelines for the digital, open, and interoperable management of the precast concrete supply chain.

# BETK results and other ongoing activities

**NEW!** **Implementation guideline UPID & AIDC for ETO products**



RAKENNUS· TEOLLISUUS

Implementation guideline for unique product identification and data carrier interoperability

Engineer-To-Order Construction products

*Release 09.01.2025*

**NEW!** **Conference article about future state (ETO) construction production model data flow architecture**

**Challenges and Opportunities in Digitalising Concrete Element Supply Chain: Proposed National Model**


Otto Alhava, otto.alhava@fira.fi
*Fira Rakennus Oy, Helsinki, Finland*

Teemu Alaluusua, teemu.alaluusua@aalto.fi
*Aalto University, Helsinki, Finland*

Antti Pekkala, antti.pekkala@fira.fi
*Fira Rakennus Oy, Helsinki, Finland*

Antti Peltokorpi, antti.peltokorpi@aalto.fi
*Aalto University, Helsinki, Finland*

Antti Aaltonen, antti.aaltonen@rt.fi
*Confederation of Finnish Construction Industries RT (CFCI)*

Tomi Pitkäranta, tomi.pitkaranta@sitedrive.com
*Sitedrive Oy, Helsinki, Finland*



**Abstract**

The introduction of takt production and the application of single-piece flow in the interior phase of construction projects has highlighted the problems in the frame erection phase of concrete element construction. Despite implementing flow production, the frame erection phase has become a bottleneck in shortening the lead time in residential building construction. The study confirmed that the design and implementation of the structural phase suffer from a lack of process and product information flows. Similarly, it was found that a contributing factor to the poor level of digitalisation is the centralised data architecture, which has been adopted in the industry using the Manufacturing to Stock (MTS) business model and strategy. As concrete element supply chains are based on a different production logic, Engineer to Order (ETO), the study defined significant differences in data architecture and operational mode of the information system. The study proposes a national or EU-level solution model for designing and exchanging product information for concrete element supply chains. Based on the case study, the research formed a national reference model for implementing decentralised data architecture and digitising inter-company data transfer. The study was conducted as part of a project by a national advocacy organisation in the construction industry aimed at digitalising the concrete element supply chain. The research results are significant in the studied market area, as they contribute to the implementation of digitalisation by demonstrating the implementation method of the data architecture for ETO supply chains and enable the same development in digitalisation for the element industry that the stock product manufacturing sector has already achieved in the digitalisation of the supply chain, wholesale operations, and the implementation of machine reading and automated data processing.



**Keywords:** distributed system, concrete element, digitalisation, supply chain, GS1, PEPPOL, ETO

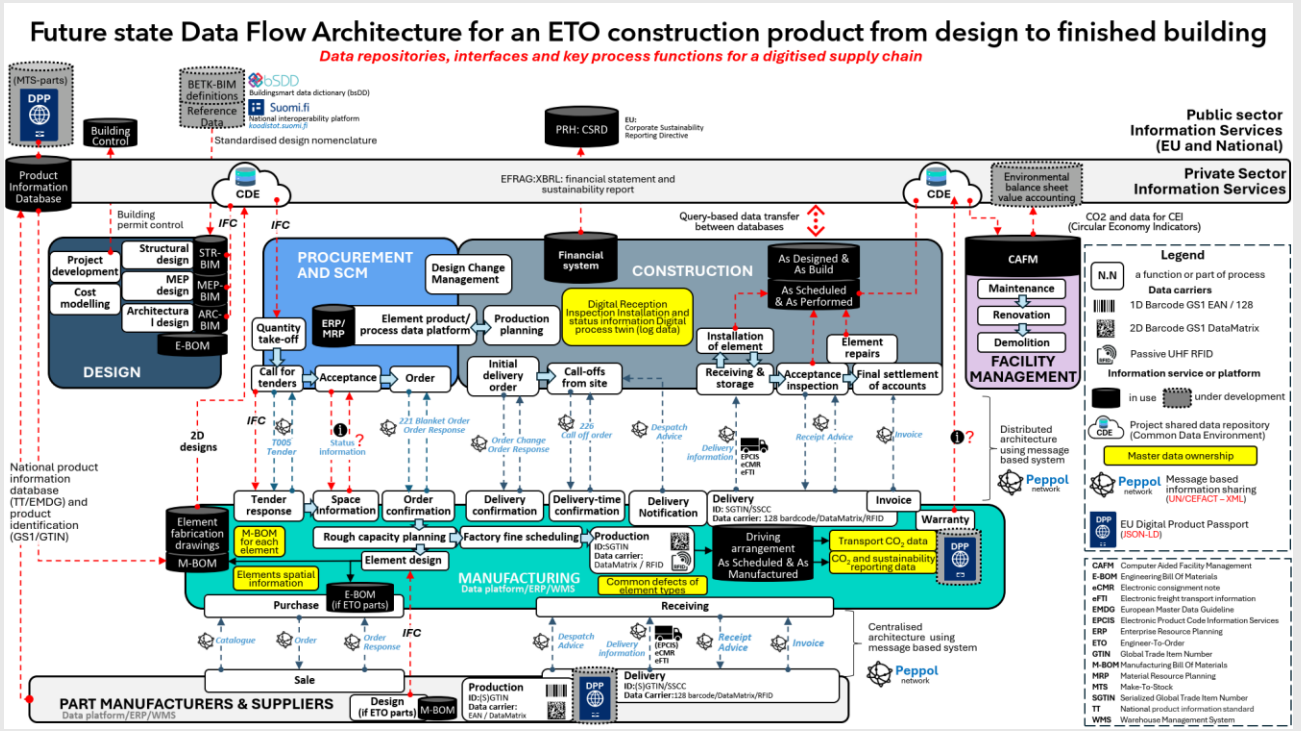

**1 Introduction**

Problems in existing manual methods of identifying, tracking and locating highly customised prefabricated components have fascinated researchers for years (e.g. Ergen et al., 2007). Several technologies and frameworks have been proposed to solve the problem of off-site production, for

CIB-W78-2024-paper_118

**Available at:**

https://betoni.com/rakentaminen/betk/betk-tulokset/

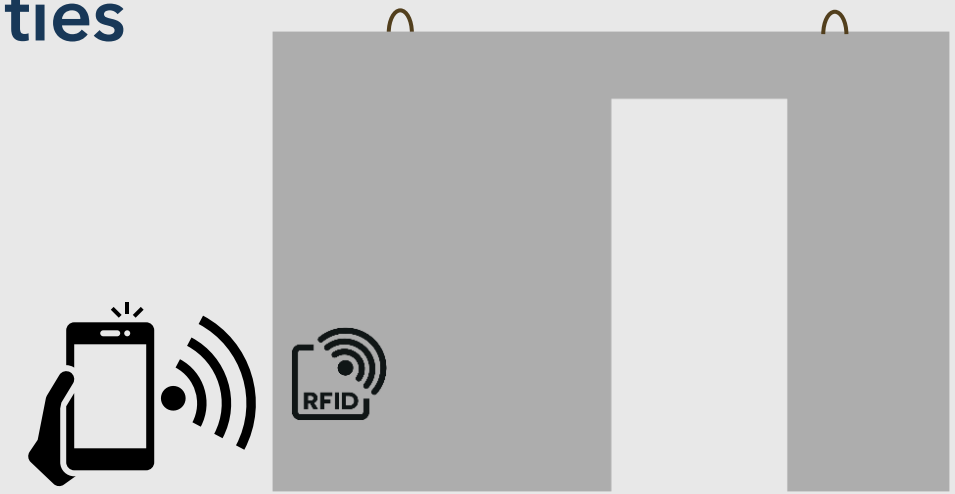


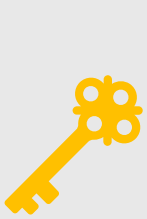
# BETK results and other ongoing activities

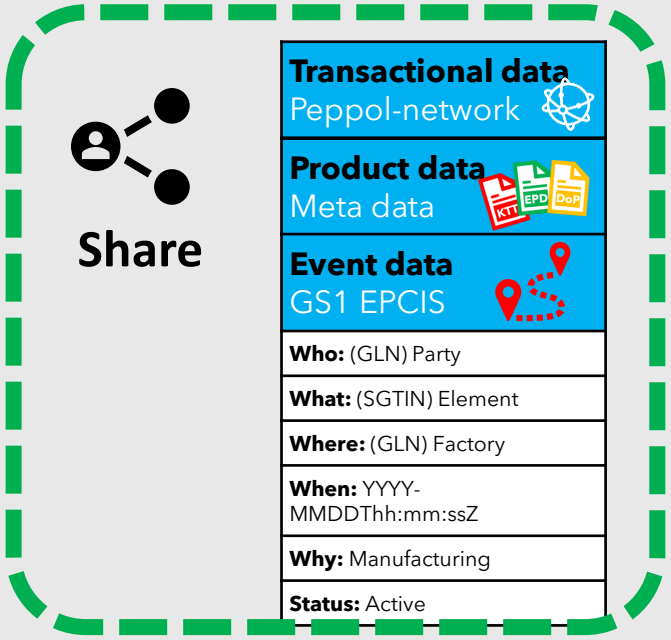
## Identification and data-capture

| LEVELS OF PRUDUCT IDENTIFICATIONS | |
|---|---|
| **Level 1:** Product identification | GTIN |
| **Level 2:** Product variation identification | GTIN + MTO Variation number |
| **Level 3** Individual product identification | GTIN + MTO Variation number + Serial number (SGTIN) |
| **GS1 APPLICATION IDENTIFIERS (AI) TO IDENTIFY ENGINEER-TO-ORDER PRODUCTS (PRECAST CONCRETE ELEMENTS)** | |
| **Minimum information requirements for the identification** | |
| **(01)** GTIN | 06400001000247 Example |
| **(242)** Made-To-Order (MTO) variation number | 123456 Example |
| **(21)** Serial number | 12345678910 Example |
| ***Optional additional information for precast concrete elements** | |
| **(91)** Finnish element classification | V1001 Example |
| **(92)** GUID | ba34cf17-0c4b-4c6f-9295-cae05aa74ad4 Example |
| (99) Domain name | id.rt.fi Example |

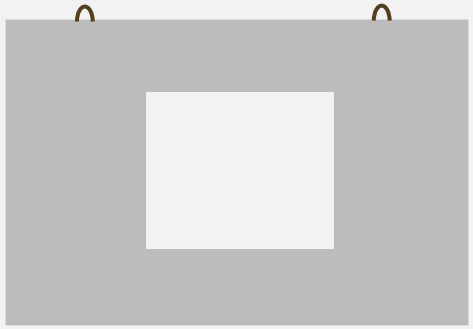
| DATA CARRIERS | | |
|---|---|---|
| **GS1 Digital Link** (2D Barcode) | **GS1 DataMatrix** (2D Barcode) | **EPC/RFID** (radio frequency remote sensing method) |
| | | |



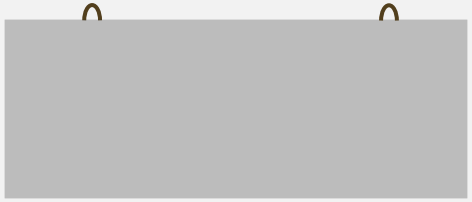





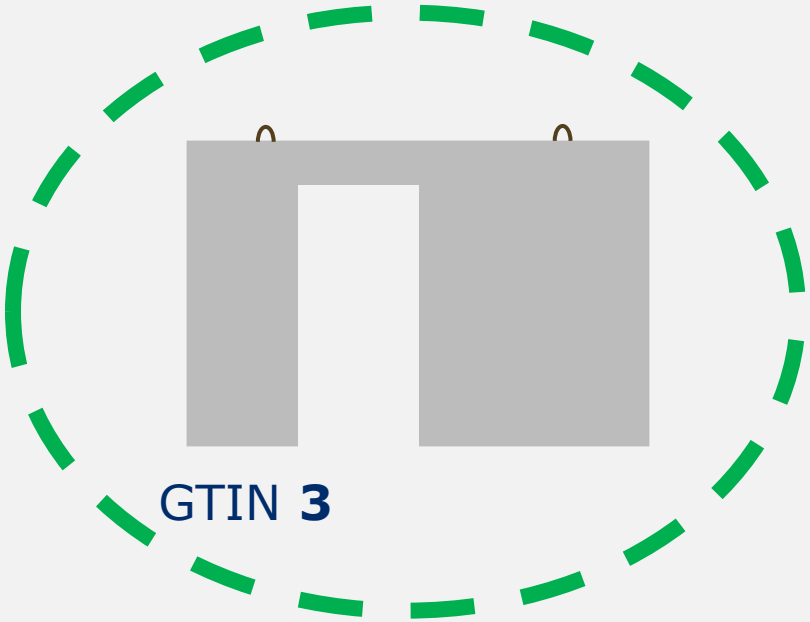
## **EXAMPLE**: use case of GS1 Product identification levels



GTIN **1**

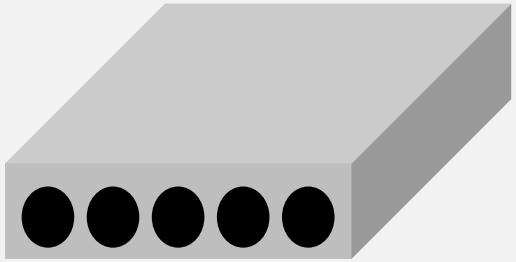


GTIN **2**



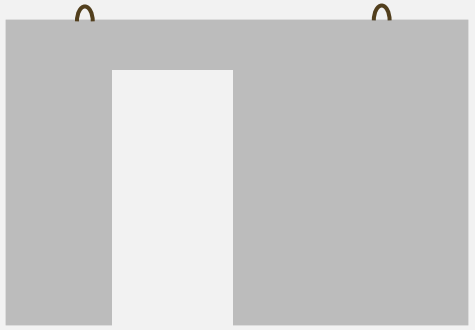
GTIN **3**

GTIN **4**



GTIN **5**

GTIN **6**



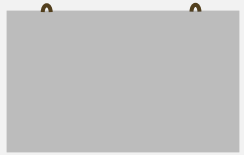
GTIN **3** +
variation number **1**

GTIN **3** +
variation number **2**

GTIN **3** +
variation number **3**

GTIN **3**
+ variation number **1**
+ serial **1**

GTIN **3**
+ variation number **2**
+ serial **1**



GTIN **3**
+ variation number **3**
+ serial **1**

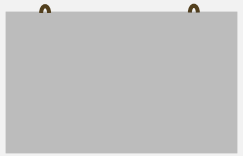
GTIN **3**
+ variation number **1**
+ serial **2**

GTIN **3**
+ variation number **2**
+ serial **2**

GTIN **3**
+ variation number **3**
+ serial **2**

GTIN **3**
+ variation number **1**
+ serial **3**

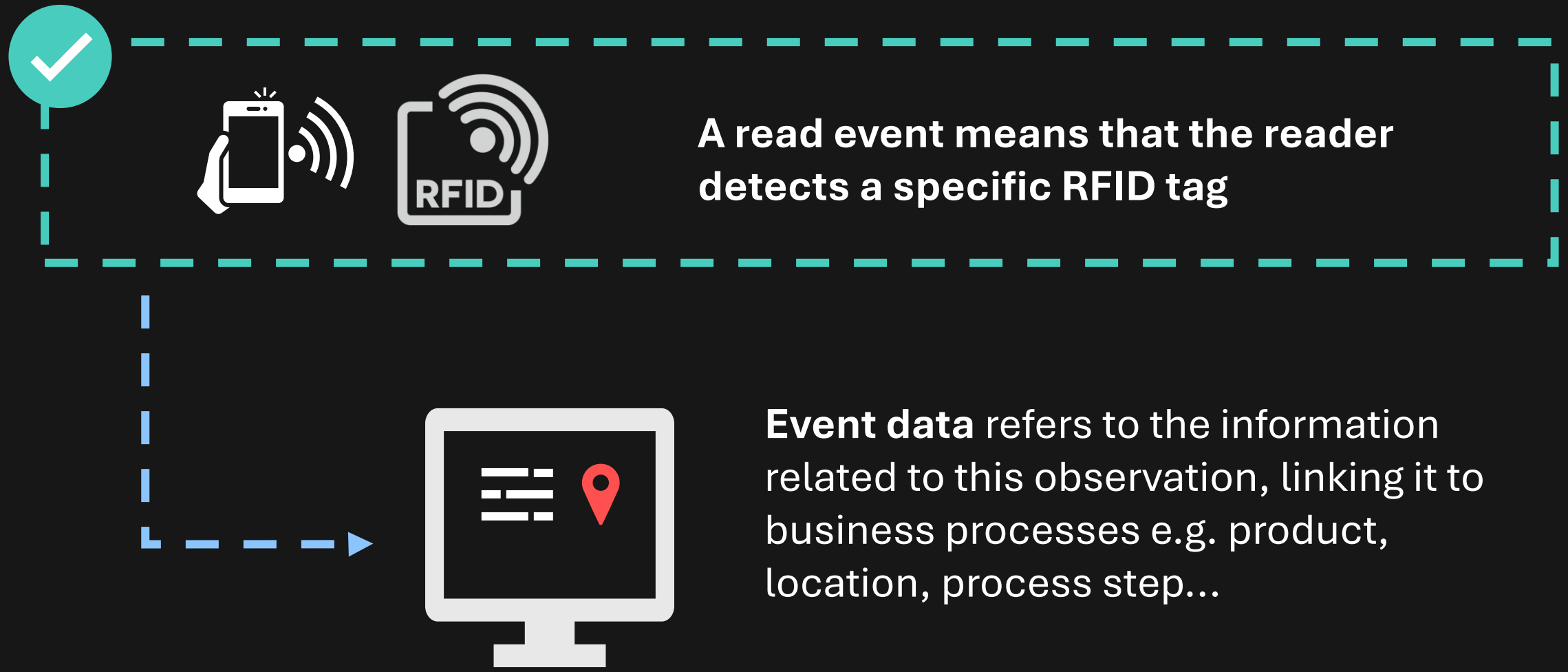
GTIN **3**
+ variation number **2**
+ serial **3**



GTIN **3**
+ variation number **3**
+ serial **3**

# The benefits of RFID are based on automated reading transactions

## **...and the resulting event data!**

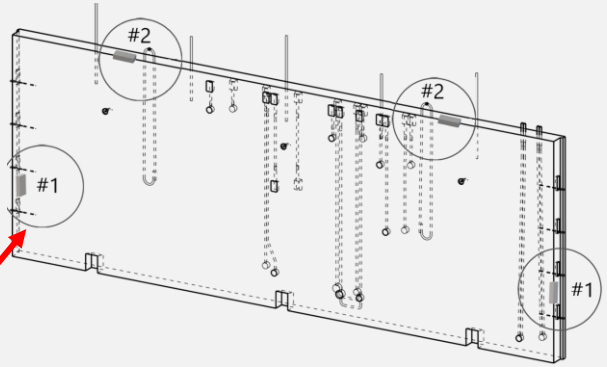



**A read event means that the reader detects a specific RFID tag**

**Event data** refers to the information related to this observation, linking it to business processes e.g. product, location, process step...

**EXAMPLE: use case of AIDC technology for event data sharing**

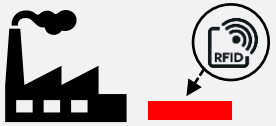
# Passive UHF RFID-tags embedded in precast concrete




Design RFID-tag places to element

Placing RFID-tags to element

Encoding UPID to passive UHF RFID tag




**What: (SGTIN) Precast concrete element**
**When: YYYY-MM-DDThh:mm:ssZ**
**Where: (GLN) Factory**
**Why: Active**

**GS1 EPCIS**

## RFID tag reading during storage and loading on factory

**What: (SGTIN) Precast concrete element**
**When: YYYY-MM-DDThh:mm:ssZ**
**Where: (GLN) Factory**
**Why: loading**

**GS1 EPCIS**

## Reading RFID tags when receiving and storing on site

**What: (SGTIN) Precast concrete element**
**When: YYYY-MM-DDThh:mm:ssZ**
**Where: (GLN) Site**
**Why: arriving**

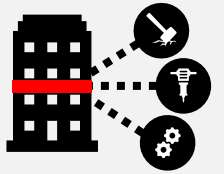
**GS1 EPCIS**


## Reading RFID tags when installing and inspecting on site

**What: (SGTIN) Precast concrete element**
**When: YYYY-MM-DDThh:mm:ssZ**
**Where: (GLN) Site**
**Why: installed**

**GS1 EPCIS**

## Reading RFID tags during product life cycle activities

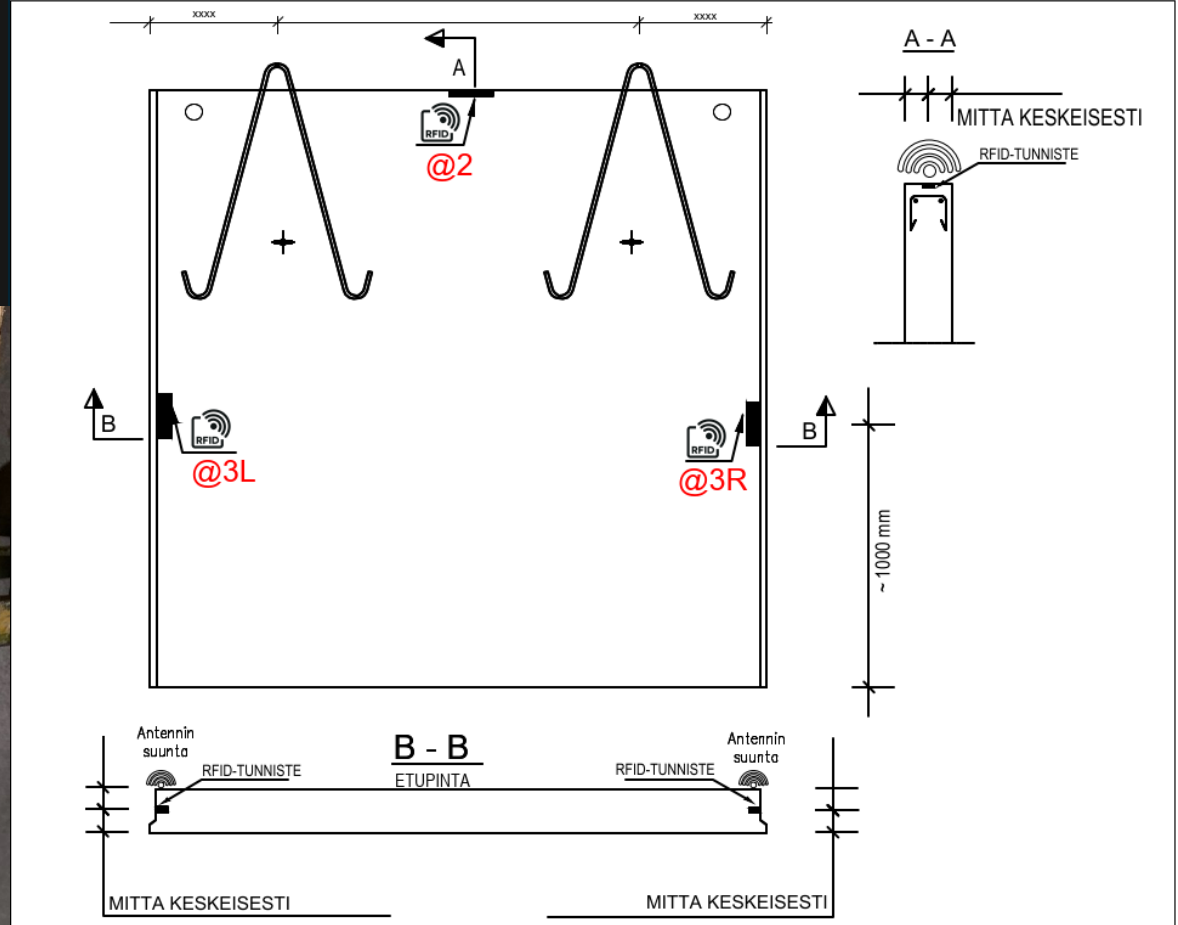


**What: (SGTIN) Precast concrete element**
**When: YYYY-MM-DDThh:mm:ssZ**
**Where: (GLN) Building**
**Why: other**

**GS1 EPCIS**

# RFID-pilot

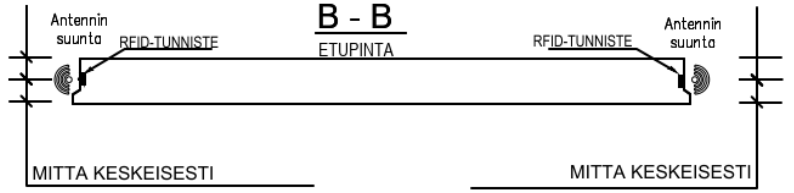





**RFID TUNNISTEIDEN ASENNUSPAIKAT**

**YLÄPINTA (@2):** RFID-tunniste sijoitetaan elementin yläpintaan. Antennin suunta kohtisuoraan ylöspäin
**PÄÄTY (@3L/R):** RFID-tunniste lisätään elementin päätyyn. Antennin suunta elementin etupintaa kohti. RFID -tunnisteen orientaatio pystysuunnassa sivun mukaisesti

BETK RFID PILOTOINTI
PVM. 29.4.2024




**RFID TUNNISTEIDEN ASENNUSPAIKAT**

**YLÄPINTA (@2):** RFID-tunniste sijoitetaan elementin yläpintaan. Antennin suunta kohtisuoraan ylöspäin
**PÄÄTY (@1):** RFID-tunniste lisätään elementin päätyyn. Antennin suunta elementin lyhyelle sivulle. RFID-tunnisteen orientaatio pystysuunnassa sivun mukaisesti

BETK RFID PILOTOINTI
PVM. 29.4.2024

RAKENNUS· TEOLLISUUS

# More information about ongoing development project

www.betoni.com/rakentaminen/BETK

**Janne Kihula**
Division Manager (precast concrete products)
+358 40 514 6510
janne.kihula@rt.fi

**Teemu Alaluusua**
Project Manager, BETK
+358 40 826 8533
teemu.alaluusua@condigi.fi
Linkedin.com/in/teemu-alaluusua

RAKENNUS-
TEOLLISUUS