CHALMERS

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Blockchain in building logistics: emerging knowledge, and related actors in Sweden

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AIM OF THIS STUDY

Consider the emerging potential of the implementation of **blockchain technology** for a new **digital business model for construction logistics**, where the **material and economic flows are integrated**, and

investigate the main constellations of **building logistics actors** in Sweden, along with the related **capabilities for the implementation for such a new digital business model**

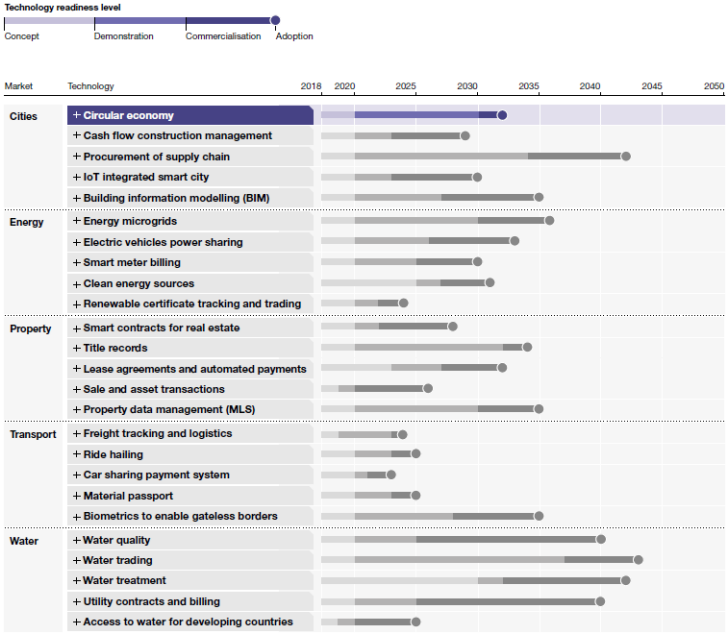
WHAT IS BLOCKCHAIN?

From a social interaction perspective:

- A team technology fostering collaboration to solve business challenges
- Peer-to-peer system for value transaction
- Digital ledger: append-only, shared, decentralized
- Reduced need for in-between verification
- New entries reflected on all database replicants hosted in ledger nodes
- **Each “block” stores a finite set of transactions- and system-related data; then blocks are connected in a fixed order**

BLOCKCHAIN IN CONSTRUCTION

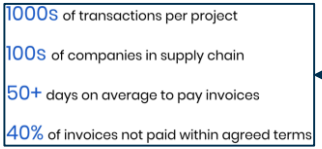
- Research on related knowledge and implementation relatively new (Penzes, 2018)
- Application systems and solutions generally not yet technologically and commercially mature (Gerber & Nguyen, 2019; Nguyen et al. 2019)
- Research mainly discretized into:
  - Holistic efforts on understanding and implementing blockchain
  - Dedicated efforts on integration of blockchain with distinct fields



BLOCKCHAIN IN CONSTRUCTION LOGISTICS

- Especially regarding construction logistics → **no investigation on utilizing blockchain for the integration of the respective material and economic flows**

Adapted from Blockchain 101 webinar (CII 2019)



- Potential benefits of such an integration through blockchain:
  - **Better overview of construction production and supply chain**
  - **Enhancing currently problematic transactions**
  - Enhancing delivery + quality management of on-site deliverables
  - Aiding in stakeholder collaboration through decentralization
  - Assisting in project constructability optimization
  - **Creating monetary and qualitative value for the stakeholders**

INTEGRATING MATERIAL + ECONOMIC FLOWS IN CONSTRUCTION LOGISTICS THROUGH BLOCKCHAIN

- Creating monetary and qualitative value for stakeholders → **value proposition of a new digital business model**
- Investigation on: different digital building logistics constellations of companies and economic flows in Sweden, and the way their operation can be facilitated with the implementation of blockchain
- Theoretical approach: **sociomateriality** (Orlikowski 2016, Buser and Carlsson 2017)

A SOCIOMATERIAL TAKE ON BLOCKCHAIN

- **Sociomateriality:** a sociotechnical approach emphasizing the way digital technologies are co-shaped with practices
- Social and material aspects of digital technologies: inseparable
- Blockchain in building logistics and supply chain management **cannot be understood separately from the relative processes and their practical realization**

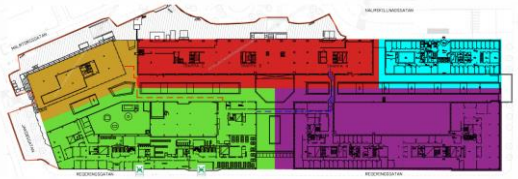
CONSTELLATIONS OF DIGITAL BUILDING LOGISTICS IN SWEDEN

- Sweden: Intensive construction activity
- Complex coordination processes → logistics-related issues:
  - Delayed deliveries
  - Complicated supply chain coordination
  - Low productivity
- There are different constellations for digital building logistics – with a potential for integration with blockchain

CONSTELLATIONS OF DIGITAL BUILDING LOGISTICS IN SWEDEN

Three main sociomaterially identified constellations:

1. **Large contractors** integrating building logistics internally **(typical case)**
2. **Independent third-party building logistics consultants** employed by clients
3. **Third-party players** (e.g. construction equipment suppliers or industrialized housing suppliers), offering digital building logistics solutions



LARGE CONTRACTORS INTERNALIZING BUILDING LOGISTICS

- Economic flow:
  - Passes through the different accounting systems of the clients and the contractors
  - Ledgers organized according to each actor's business practice – rarely structured commonly
- Transition to a digital business model utilizing blockchain for building logistics with integrated material and economic flows:
  - Generalized, decentralized and common digital ledger used by all related actors → the discrepancy in the utilization of different accounting systems significantly mitigated
  - Normalization due to the append-only aspect of the block creation, and the immutability of the chain itself → facilitating the decentralization in the relative processes

INDEPENDENT BUILDING LOGISTICS CONSULTANTS

- Economic flow: at present, often organized in parallel to the model of the large contractors internalizing logistics
- Transition to a digital business model utilizing blockchain for building logistics with integrated material and economic flows:
  - Facilitating agility in integrating: (i) the logistics planning and flow control system, and (ii) the material registration, placement and installation
  - Ameliorating still existing hindrances in consultants' efforts (e.g. delivery failure, unprecise data retrieval, delays, intra-systemic inefficient flows and data transfer)
  - Resolving ambiguities in the economic flow – consultants still have to justify the value-for-money for their services when coordinating the to-be-paid invoices after finished deliveries and/or works

3rd PARTY ACTORS OFFERING DIGITAL BUILDING LOGISTICS SERVICES

- Economic flow: decentralized
- Transition to a digital business model utilizing blockchain for building logistics with integrated material and economic flows:
  - Furtherly streamlining the decentralized economic flow of on-site planning (already "flattened" to ease on-site congestion)
  - Furtherly streamlining the multiple material flows connected to the differently designated site areas and access points

DISCUSSION

- Building logistics in Sweden → possible field of blockchain implementation
- Different constellations with different business models:
  - Different modes of collaboration between the participants in a blockchain network
  - **Different sociotechnical solutions involving characteristic distributions of power**, rather than just technical choices among rationally discernible models
- Operational frameworks dependent on knowledge exchange, but also a political game

DISCUSSION

- Blockchain security issues (and the need for mutual trust):
  - Internal trust among participants in a blockchain network, where there is reduced control, should be cultivated – however, this is difficult
  - Autonomy-control paradox (Bader and Kaiser 2017, Zuboff 2019)
  - Possible solution: **setting up a permissioned system and following a series of procedures** to protect the blockchain network from external threat, but also internal instabilities
- Blockchain integration issues:
  - Technical interoperability
  - Changes in the work practices and organization of the participants
- Blockchain technology introduction issues:
  - First, as an add-on to an information infrastructure consisting of different accounting, project and site planning, and quality and access control systems
  - Then, common standards, not only for building components, but also for the ledger structuring, should be possibly adopted

CONCLUSIONS

- Blockchain: emerging technology with potential for the construction sector
- Relative present systems immature
- Disintegration of material and economic flows in construction logistics and supply chain management: **major issue → integration could be facilitated through blockchain**
- Each of the three main sociotechnical building logistics constellations in the Swedish context is characterized by its own challenges and power structure
- Implementing blockchain in the constellations entails negotiations, and requires tackling of **security, integration, and technology introduction** issues
- **Cross-fertilization** of blockchain with the IoT, machine learning, digital twin, automated vehicles, augmented reality, and other digital technologies → possible

THANK YOU FOR YOUR ATTENTION!

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