CHALMERS

2019 EC³

# Blockchain in construction logistics: state-of-art, constructability, and the advent of a new digital business model in Sweden

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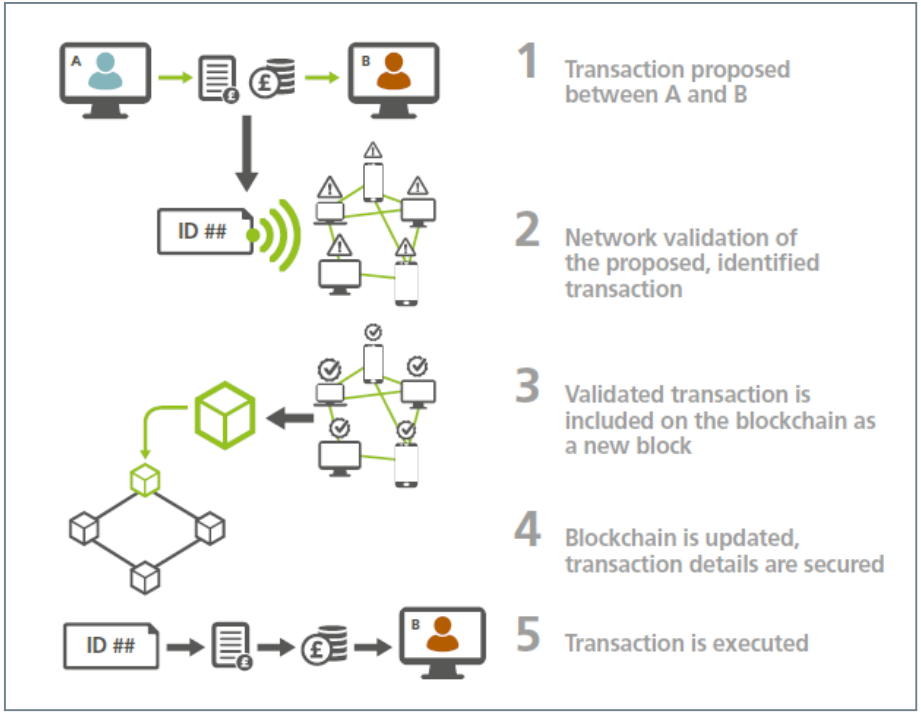
# WHAT IS BLOCKCHAIN?

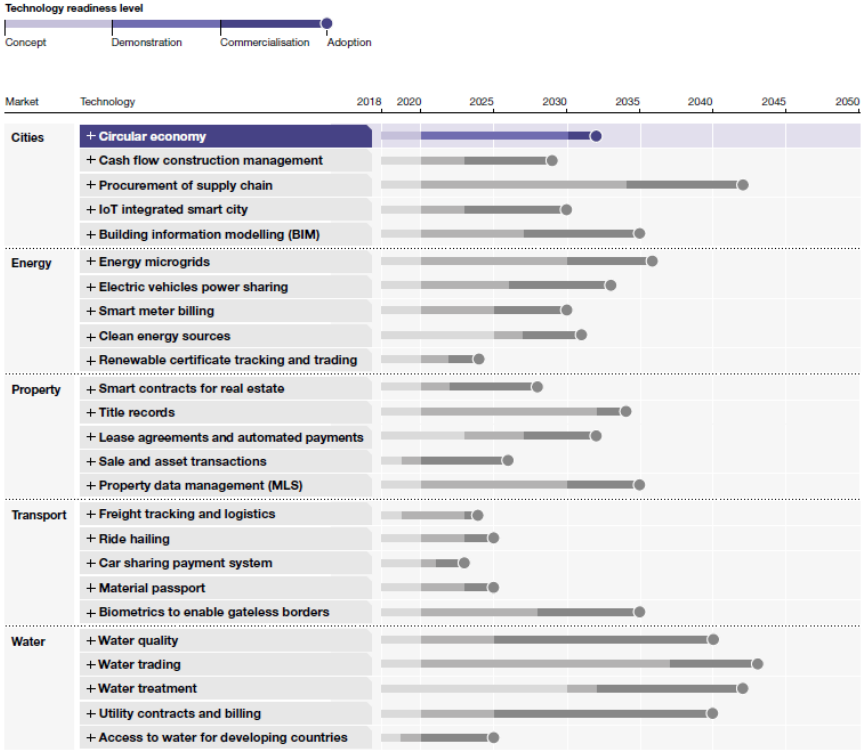
- Peer-to-peer system for value transaction
- Digital ledger: append-only, shared, decentralized
- Reduced need for in-between verification
- Acts as a layer on top of other technologies
- Every entry permanent & immutable; new entries reflected on all database replicants hosted in ledger nodes
- **Each "block" stores a finite set of transaction- and system-related data; then blocks are connected in a fixed order**




*Adapted from Penzes (2018)*

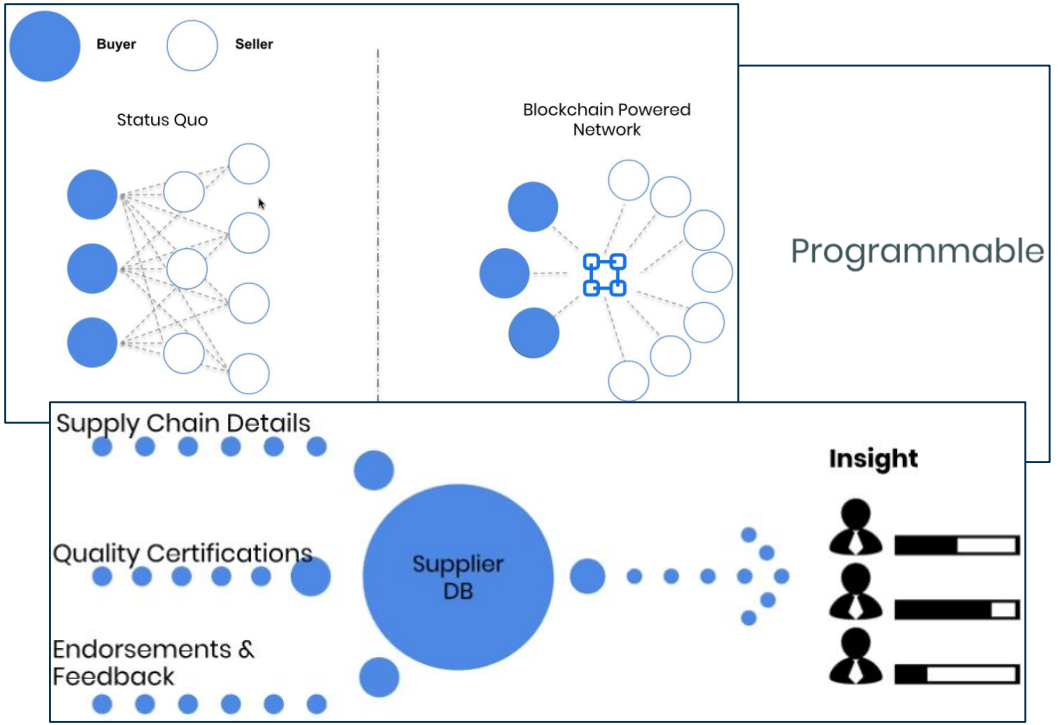
# BLOCKCHAIN IN CONSTRUCTION

- Research on development 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

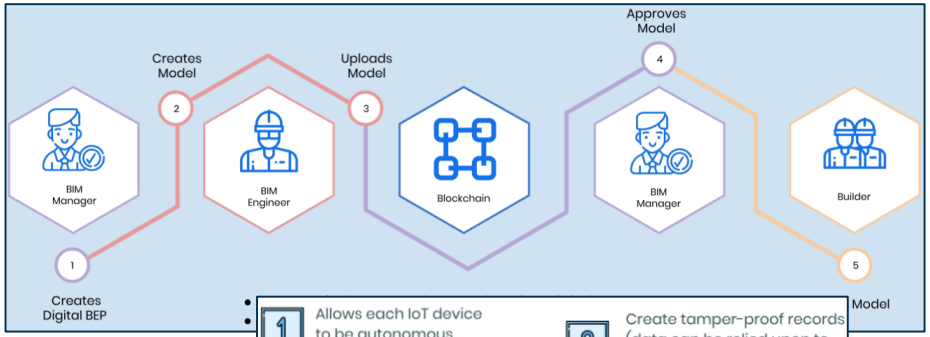
- Holistic research efforts
  - Lateral connection of blockchain with existing processes (e.g. procurement, re-engineering)
  - Proposal of new integrated frameworks (mainly addressing technology implementation processes)

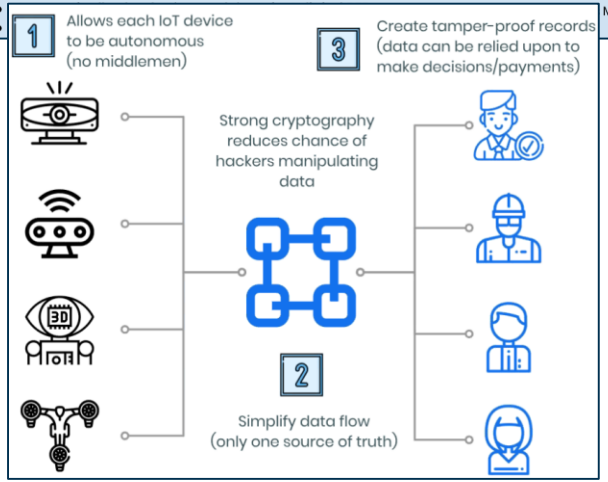



*Adapted from Blockchain 101 webinar (CII 2019)*

# BLOCKCHAIN IN CONSTRUCTION

- Dedicated research efforts
  - Implementation of smart contracts for all transactions
    - Computer protocols facilitating contract negotiation or performance
  - Interconnection with BIM
    - Facilitating trust among stakeholders
    - Resolving data issues
  - Integration with IoT
  - Interconnection with CAD
  - Interconnection with RFID for logistics and site management




*Adapted from Blockchain 101 webinar (CII 2019)*

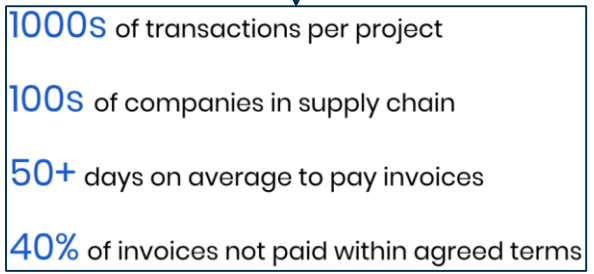
# BUT…

- Especially regarding construction logistics and supply chain management → **no investigation on utilizing blockchain for the integration of the respective material and economic flows**
- Not investigated even in previously mentioned construction logistics + blockchain investigated cases
- Only sparse considerations on this integration – but not with blockchain

# … AND WHY?

**Benefits from integrating the material + economic flows in construction logistics through blockchain**

- Overview of construction production and supply chain
- Enhancing currently problematic transactions
  - Time + cost savings in construction
  - Higher profit margin
  - Safer timetables with fewer delays
  - Less administrative redundancy + duplication: fewer data errors and interruptions
  - Better and safer transaction management
  - Fostering trust, transparency and traceability




*Adapted from Blockchain 101 webinar (CII 2019)*

# … AND WHY?

**Benefits from integrating the material + economic flows in construction logistics through blockchain**

- 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**

# INTEGRATION OF MATERIAL + ECONOMIC FLOWS IN CONSTRUCTION LOGISTICS THROUGH BLOCKCHAIN

- Creating monetary and qualitative value for stakeholders → **value proposition of a new digital business model**
  - Business model:
    - Proposing and creating value for key stakeholders and clients
    - Monitoring key activities, resources, relationships and flow channels
    - Understanding related cost structure
    - Facilitating revenue streams
  - Digital business model: a business model in a digitalized context
  - Value proposition: creation of value for clients willing to pay for it, thus converting it into turnover and profit for the firm

# INTEGRATION OF MATERIAL + ECONOMIC FLOWS IN CONSTRUCTION LOGISTICS THROUGH BLOCKCHAIN

- Conceptual foundations of such an integration

  - **Deployment of decentralized blockchain network** → nodes correspond to supply chain actors (e.g. clients, contractors, subcontractors, suppliers, transporters, and **logistics consultants – see following slides**) → network is a shared, immutable ledger with transactional history data
  - **Direct connection of payments to suppliers and transporters**, also potentially using IoT – e.g. data about arrival of materials and equipment can trigger smart contracts automatically supporting the sending of the payments to the relevant actors
  - **Tracking origin and cross-checking quality of supply chain inputs** (e.g. gravel, cement) through the append-only block sequence → smart contract triggers related to payments could also include clauses considering such cross-checks

# INTEGRATION OF MATERIAL + ECONOMIC FLOWS IN CONSTRUCTION LOGISTICS THROUGH BLOCKCHAIN

- Challenges
  - Security issues
  - Potential initial ambiguity about value creation
  - Potentially difficult to implement without simultaneous implementation of IoT
  - Stimulation of stakeholders into adopting such a new digital business model
- Limitations
  - Little understanding of blockchain within construction logistics → dedicated knowledgeable practitioners relatively rare → outsourcing to blockchain technicians not necessarily familiar with construction logistics
  - Cryptocurrencies may be increasingly accepted as means for transactions, but not by all in the construction industry


*Adapted from Blockchain 101 webinar (CII 2019)*

# HOW?

- Lessons-learned for such an **integration** from blockchain applications in other fields:
  - Insights from manufacturing
    - Dissimilarities on project complexity, configuration intensity, customer influence, process fragmentation, and stakeholder interconnection…
    - … but, manufacturing supply chains made of discernible processes and flows could correspond to the construction supply chain processes and flows
  - Capabilities of already developed blockchain systems

# HOW?

- Interfaces for such an **integration** with construction-specific frameworks of production and management (interconnected with supply chains):
  - Constructability
  - Lean construction
  - Component prioritization for economic flow optimization
  - Chosen contractual strategy

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

- Urbanization and construction activity in Sweden: intensified
- Issues:
  - Delayed deliveries
  - Complicated supply chain coordination
  - Low productivity and efficiency
- To confront such issues and facilitate logistics, a state-of-art business practice is employing **independent third-party logistics consultant firms**

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

- Independent third-party logistics consultant firms:
  - Often small organizations
  - Usually hired by client, seldomly by main contractor
  - Coordinate and handle complex, recurrent and conflicting flows
  - Coordinate supply chain by connecting supply chain actors
  - Embody a business model for improved construction logistics

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

Prominent third-party logistics consultant firms within the Swedish construction sector

| Name | Turnover (2017-8) | Staff no. | Industry | Main clients | Approach | Digital solution? |
|---|---|---|---|---|---|---|
| **LogTrade** | ≈ 2.328 M € | 9 | Construction, manufacturing, retail, transportation | Contractors, suppliers, distributors, retailers, transporters | Digitalization/automation | Yes, in-house |
| **Myloc** | ≈ 1.483 M € | 8 | Construction, real estate, inventories, manufacturing | Contractors, suppliers, distributors, manufacturers | Digitalization/automation | Yes, in-house |
| **Prolog Bygglogistik** | ≈ 1.905 M € | 22 | Construction, real estate | Contractors, suppliers, distributors, transporters | Facilitation/ digitalization/ automation | Yes, with external partner |
| **Servistik** | ≈ 2.749 M € | 20 | Construction, manufacturing, waste management | Contractors, suppliers, distributors, manufacturers, transporters | Facilitation/ digitalization/ automation | Yes, in-house |
| **Svenskt Byggdialog** | ≈ 100.871 M € | 138 | Construction, real estate | Contractors, suppliers, manufacturers | Facilitation/ digitalization/ automation | Yes, in-house |
| **Svenskt Bygglogistik** | ≈ 4.167 M € | 25 | Construction, real estate, transportation | Contractors, suppliers, distributors, transporters | Facilitation/ digitalization/ automation | Yes, in-house |
| **FM Management** | ≈ 2.337 M € | 8 | Construction, real estate, transportation | Contractors, suppliers, distributors, transporters | Facilitation/ digitalization/ automation | Yes, with external partner |

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

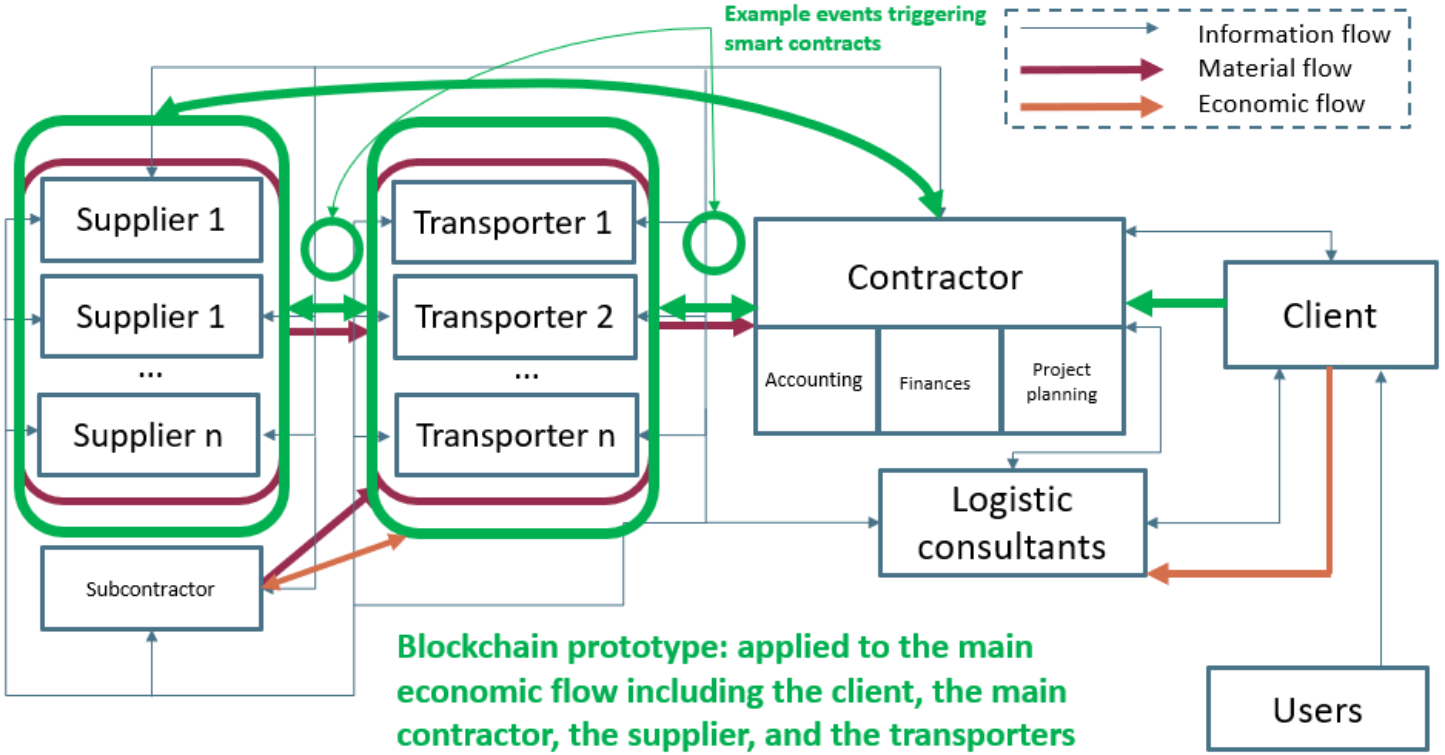
- Independent third-party logistics consultant firms:
  - No established approach and level of digitalization
  - In a broader perspective, other actors can influence the hiring of independent third-party logistics consultant firms
    - **Equipment suppliers, offering customized logistics solutions**
    - **Dominance of contractor-driven building logistics → contractors using in-house logistics services**

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

- Independent third-party logistics consultant firms:
  - **Blockchain can optimize efficiency and mitigate costs of their collaborative business models**
  - **Properties of blockchain align with viewing these digital business models inter-organizationally and not only as single-company efforts**
  - **A digital approach could be integrated with the flow control system, involving blockchain in handling the economic and material flows**

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

Initial generic concept of the blockchain solution (Swedish case)



# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

- Such a blockchain solution, **embedded in a new digital business model**, could also help in issues faced by the independent third-party logistics consultant firms:
  - Still existent delivery failures, unprecise data, delays in time, inefficient flows and data transfers between systems
  - On-site physical placement rarely tied to digital solutions
  - Difficulties in justifying value-for-money – decoupling between payments for deliveries and transportation services, and payments for the logistics solution → results on the disintegration of the material and economic flows

# NEW DIGITAL BUSINESS MODEL – THE CASE OF SWEDEN

Early conceptual and generic digital business model canvas

<table>
<tr>
<td>Key partners<br>Logistics consultants<br>IT infrastructure specialists<br>Clients<br>Main contractor<br>Subcontractors<br>Material suppliers<br>Retailers<br>Transporters</td>
<td>Key activities<br>Construction project production and management<br>Key resources<br>Monetary<br>Human<br>Technological<br>Material</td>
<td rowspan="2">Value proposition<br>The logistics processes will be quicker, more efficient, more comprehensive, and more automated. The transactions and payments will be more secure, instant, decentralized, correct, and transparent. The optimization of the integrated flows will allow less rework, better change management, and optimized site operations. The role of economically dependent stakeholders (e.g. subcontractors) will be enhanced in a lateral manner.</td>
<td>Customer relationships<br>Close collaboration<br>Dynamic transactions<br>Peer-to-peer<br>Channels<br>As created by the operation of the nodes<br>Integration of material and economic streams</td>
<td>Customer segments<br>As created by the segmentation of the process through the implementation of disruptive blockchain technology</td>
</tr>
<tr>
<td colspan="2">Cost structure<br>Cost paid by the client and/or main contractor<br>Included in the fees of the logistics consultants and/or IT specialists</td>
<td colspan="2">Revenue streams<br>As created by the operation of the nodes in the blockchain<br>Decentralized, secure, transparent, and resulting through instant transactions</td>
</tr>
</table>

# CONCLUSIONS

- Blockchain: emerging technology with disruptive potential for the construction sector, including construction logistics
- Actual implementation systems not technologically mature, but there is growing relative research and development
- Disintegration of material and economic flows in construction logistics and supply chain management: major issue → could be facilitated via blockchain implementation

# CONCLUSIONS

- Operation of third-party independent logistics consultant firms in Swedish construction sector: both a fertile ground for and in need of an integrated blockchain solution
- Embedding blockchain into a new digital business model
- Robust conceptualization and development of such a digital business model cannot be disintegrated from the operational processes and business models of the actors collaborating with the third-party logistics consultants

# ONGOING WORK

- Research on business models of construction supply chain actors in Sweden
- Explicit identification, for each stakeholder, of the value creation from implementing an integrated blockchain solution
- Research on best-practices and lessons-learned from business models of global logistics firms operating in Sweden
- **Particularization of the proposed early conceptual and generic digital business model into a dedicated digital business model for the independent third-party logistics consultants in Sweden**

# ONGOING AND FUTURE WORK

- Developing the blockchain solution: prototype featuring integration of flows, a distributed network, smart contracts, on-site triggers, and end-user application
- On-site prototype testing and verification, with the attendance of the actors represented by the relative nodes in the distributed network

# THANK YOU FOR YOUR ATTENTION!

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