Cooperation enhanced by decentralization in the building industry:

Blockchain enabled asset management in the X-Decks case

P5 – Benjamin Weihs
Overview

1. Research framework
2. Problem statement
3. Literature review
4. Scenarios / KPIs
5. Interviews
6. Blockchain enabled asset management framework + Prototype
7. Further research & Conclusion
Hierarchical organigram

- Investor
  - Developer
    - Contractor
      - Sub contractors
        - Manufacturer
      - Sub contractors
        - Manufacturer
      - Sub contractors
        - Manufacturer
Frictions
Frictions

• Construction execution varies in duration, which creates uncertainty. Independent decision makers at the resource-base level tend to act in their own interests rather than in the interests of the collective.

• Exposing information about costs and revenues to external stakeholders, can easily turn into competitive disadvantages

• Suppliers have information that is critical for effective client decision-making, but are not motivated to fully share that information (Winch, 2010)

• Buyers cannot easily monitor the quality of the goods or services received, and so suppliers are tempted to substitute lower quality goods or be less than diligent in the supply of services.
Current status

- Sell and buy back common practice
- Modular, easy to assemble/disassemble (6 weeks)
- Hierarchical organizational structure
- Separate entity acts as a contractor
- “50% circular”
X-Decks concept
Royal HaskoningDHV

Cashflow

Performance

Land €/m²/month

Park €/m²/month

‘Recepten’ ‘Legodoos’

Objects

Structure €/object/month

Floors €/object/month

MEP €/object/month

€/hour

RHDHV(2017)
Individual ledger

Shared ledger

IBM (2017)
X-Decks + Blockchain
X-Decks + Blockchain =
1. Literature review
   - Aim: Define scope of research
   - Methods: Desk Research, Literature review
   - Result: Provide theoretical background of blockchain technology

2. KPI Selection & create scenarios
   - Aim: Identification of key performance indicators and possible scenarios for the X-Decks case
   - Methods: Literature Review, Case study, Semi-structured interviews
   - Result: List of Key Performance Indicators to evaluate X-Decks case and three future scenarios

3. Building asset management framework
   - Aim: Process interviews and shape a tailor-made blockchain asset management framework for the X-Decks case
   - Methods: Desk research, Case study, Semi-structured interviews
   - Result: Use data from interviews to evaluate scenarios, KPIs and create asset management framework

4. Translate framework into prototype
   - Aim: Use previously gained insights and data to create a first blockchain asset management program
   - Methods: Expert feedback, Desk research, Coding
   - Result: Blockchain enhanced asset management program for X-Decks

5. Bundle results
   - Aim: Show extended opportunities for X-Decks through blockchain technology
   - Methods: Discussion, Reflection
   - Result: Answer research questions - Discussion and reflection - Recommendation from research and practice

Process:
- P1/P2: Research Framework
- P2: Practical Framework
- P3: Practical Framework
- P4: Final Product
Main Research Question

How can asset management in the supply chain of the X-Decks case be applied to a blockchain enabled asset management framework?
Sub Questions

1. What is blockchain and how can it facilitate decentralised utilities?
2. What are the key features of the blockchain technology in application to the X-Decks case?
3. What are likely adoption scenarios for blockchain-based trading in the parking industry?
4. What roles can current market parties play in such a system?
5. How can different stakeholder attitudes affect the framework?
1. What is blockchain and how can it facilitate decentralised utilities?
Key concepts

Centralization, dezentralization, distribution
What is a blockchain?

Peer-to-peer networks with public-key cryptography, timestamping of transactions along with a distributed consensus algorithm

Zhijie Ren (2017)
A chain (sequence, typically a hash chain) of **blocks** of transactions

- Each block consists of a number of (ordered) transactions
- Blockchain establishes total order of transactions

Consensus protocol ensures ledger replicas are Identical*
Consensus

Confirms the correctness of all transactions in a proposed block, according to endorsement and consensus policies

Agrees on order and correctness and hence on results of execution (implies agreement on global state)

Interfaces and depends on smart-contract layer to verify correctness of an ordered set of transactions in a block
Consensus

• **Byzantine Fault Tolerant (BFT)** - number of nodes that must reach consensus is $2f+1$ in a system containing $3f+1$ nodes. For known and trusted participants

• **Proof of Stake (PoS)** - here nodes are randomly selected to validate blocks, and the probability of this random selection depends on the amount of stake held.

• **Proof of Work (PoW)** - is first utilized by Bitcoin that involves solving a computational challenging puzzle in order to create a new block. Significant compute cost. For anonymous participants

• **Tangle** - carries no economic incentive. Instead, it is designed in a way that requires all users to verify two transactions each time they wish to carry out one of their own. The Tangle is related to the IOTA project.

• **Proof of Elapsed Time (PoET)** - is introduced by Intel and provides a hardware based solution that utilizes a lottery function in which the node with the shortest wait time creates the next block.

• **Multi-signatures validation** needs consent from 3 out of 5 validators
Smart contracts

```
contract Crowdfund:
    if (account_balance > $10000)
        move account_balance to funded_account
        tell invoicing_system to send_shirt
    else
        move donation_account to original_donor
```
Private and public blockchains

- Low Security: Permissioned Private ledger
- High Security: Unpermissioned Public Ledger

- Low Cost: Permissioned Public ledger
- High Cost: Unpermissioned Public Ledger

Credit Suisse Research (2017)
Hyperledger (2018)
Blockchain evolution

2009

Bitcoin

- A hard-coded cryptocurrency application with limited stack based scripting language
- Proof-of-Work consensus
- Native currency BTC
- Permissionless blockchain

2014

Ethereum

- Distributed applications (smart contracts) in domain specific language (Solidity)
- Proof-of-Work consensus
- Native currency ETH
- Permissionless blockchain

2017

Hyperledger Fabric

- Distributed applications in different general-purpose languages
- Modular / pluggable consensus
- No native cryptocurrency
- Multiple instances / deployments
- Permissioned blockchain system
Challenges of adaption and deployment

X-Decks related

• Misconceptions and lack of knowledge
• Confidentiality vs transparency (private vs public)
• Finding and replacing paper based processes
• Gap between digital twin and physical asset
• Reaching critical mass of participating stakeholders

• Avoid under all circumstances to commit any personal data to a blockchain – it will stay there forever (GDPR – EU privacy law)
Challenges of adaption and deployment

STANDARDS ROLE IN SUPPORTING BLOCKCHAIN/DLT

Security, Privacy, and Data Governance
End-user Identity
Provenance Tracking
Technical Aspects

Terminology and Vocabulary
Interoperability

Short Term
Medium Term
Long Term

Linux Foundation(2017)
2. What are the key features of the blockchain technology in application to the X-Decks case?
Key features for the X-Decks case

• Enhance transparent processes and collaboration

• Distribution of liabilities makes middlemen redundant

• Improved traceability of assets, contracts and metadata e.g. for a building passport

• Start with a limited number of stakeholders (permissioned, private blockchain) and scale up the network step by step
KPIs

Business and Information flows
• Role and responsibilities of stakeholder
• Business model
• Payment structures and conditions
• Information flows

Applies to all categories:
Transparency & collaboration

Innovation & Fictions
• Contractual procedures
• Parking as a service
• Circular processes
• Organizational silos
• Financing

Blockchain
• (Mis)conceptions / Expectations
• Needs
• Limitations and Opportunities
• Replacement of middlemen
3. What are likely adoption scenarios for blockchain-based trading in the parking industry?
Investor

Developer

Contractor

Sub contractors

Manufacturer

Sub contractors

Manufacturer

Sub contractors

Manufacturer
Investor

Developer

Contractor

Sub contractors

Manufacturer

Sub contractors

Manufacturer

Sub contractors

Manufacturer

RHDHV

Sub

Investor

Manufacturer

Operator

Sub

Manufacturer

RHDHV

Sub

Operator
Scenarios
Now

Mid-term (+- 2020)

Long-term (from 2025)
4. What roles can current market parties play in such a system?
Traceability of assets across the X-Decks lifecycle with a digital twin
Interview
Main findings
for framework
<table>
<thead>
<tr>
<th>Topic</th>
<th>Interview Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of Stakeholder</td>
<td>What was the main problem or need that is covered by your company’s product or service (for the X-Decks project)?</td>
</tr>
<tr>
<td>Business and Information Flows</td>
<td>How were you contracted and paid – can you describe the process looking back at the last three projects you have worked on / the last three contracts that you signed with contractor / investor / developer / supplier / manufacturer?</td>
</tr>
<tr>
<td></td>
<td>What kind of information and assets were stored, monitored and transferred, and which technologies were used to do so? Which partners were important for your own business model?</td>
</tr>
<tr>
<td>Blockchain technology</td>
<td>Were there any blockchain related projects at your company? If no: What do you know about blockchain technology? Did you heard about any applications (in building industry)? Did you ever got the chance to invest materials or working hours to hold shares of a building project?</td>
</tr>
<tr>
<td>Blockchain enabled framework</td>
<td>What did you think of the suggested process via blockchain technology? What kind of barriers or roadblocks would you imagine in the blockchain space? Do you see other opportunities that can benefit from blockchain technology?</td>
</tr>
</tbody>
</table>
Main findings

• Make it **easily possible to join, leave and change position** of a node in every layer of the **blockchain network**

• **Reduction of the risk budget** during the building process and exploitation of new business models are the main motivations to use technological innovation

• Documentation of financial and operational data is not happening yet – just at later stages not from the beginning of building process
• It became clear to make a generic purpose tool for asset trading that creates capacity and offers interfaces to connect with additional services in the future (scalable)

• Need for more transparency to overcome organizational silos. Or more precise to find a balance between preserving silos to run a business model and opening it up to enhance collective model and data collection

• Reservation towards actively developing a prototype and holding shares in X-Decks which might be caused by conducting the interviews at an early stage of the research with just the scenarios available
Blockchain enabled asset management framework

How can asset management in the supply chain of the X-Decks case be applied to a blockchain enabled asset management framework?
1st Model
e.g. land gets 30% reduced due to lower demand
Change asset value or sell asset

OMU
propose
declined

Land

accept

Log on chain

Shares:
Estimated total costs:
3.5m Eur
20% of shares for OMU

Tech. specs
- 7000sqm
- plain
- covered with grass

Fin. value
- 100Eur/sqm
- 0.7m Eur

validate

Metsä
TBI
RHDHV

OMU others
2nd Model
3rd Model
Shares as tokens

Create 10,000 tokens

Pay 0.00001 tokens/h

Acquire tokens

S
Stakeholder of core consortium (Validating peer)

E
Data Item

Pc
External B2B stakeholder (Non-validating peer)

Pi
External customer (Non-validating peer)

External investor (Non-validating peer)
Prototype demo

https://github.com/3en3en/xdecks-network
Prototype demo

- Propose
- Accepted
- Declined
- Change asset value or asset attributes or sell asset
- Log on chain
- Stakeholder of core consortium
- Data Item
Business network file structure

- **Assets**: Participants, Transactions
  - **Model File**: `.cto`
- **Transaction Functions**
  - **Script File**: `.js`
- **Access Control**
  - **Access Control File**: `.acl`
- **Query Definitions**
  - **Query File**: `.qry`

Use Composer to create a Business Network Definition, comprised of Model (.cto), Script (.js), ACL (.acl) and Query (.qry) files.

Package up your Business Network Definition and export it as an archive (.bna file) ready to deploy it somewhere.

- **Hyperledger Fabric**
  - Cloud / Local
- **Web Browser / Node.js**
  - Online

Use ID Cards (which include connection profiles and credentials) to deploy your Business Network Definition to a distributed ledger.

*Linux Foundation (2018)*
Further research

• Continue to involve stakeholders, concretize chances, liabilities, success factors

• Connect building passport, Digital Twin & smart contracts
Further research
Conclusion

• Liabilities and shares to become part of a core consortium are new duties for the stakeholders and are faced with reluctance
Conclusion

• Liabilities and shares to become part of a core consortium are **new duties** for the stakeholders and are **faced with reluctance**

**BUT**
Conclusion

• **Liabilities and shares** to become part of a core consortium are **new duties** for the stakeholders and are **faced with reluctance**

BUT

• Blockchain can create a new, **trustable environment** to facilitate organizational, managerial and financial changes that are **very much needed by all stakeholders** to lower risks, enhance cooperation, transparency and agility.
Conclusion

• **Liabilities and shares** to become part of a core consortium are **new duties** for the stakeholders and are **faced with reluctance**

**BUT**

• Blockchain can create a new, **trustable environment** to facilitate organizational, managerial and financial changes that are **very much needed by all stakeholders** to lower risks, enhance cooperation, transparency and agility

**AND**

• Seeking for new solutions can result in **competitive advantages to enter new business segments** over the **whole lifecycle of a building** and strengthen the stakeholders’ role as a **pioneer in the field of digital transformation** in the build environment. **+X-Decks suitable case**
Students earn money with blockchain enabled parking project

Will this shake the real estate industry?

First of its kind