Blockchain for
Transparent Food Supply Chain
SDLT, 2018

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Food Safety?

Dangers in Baby Food

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepared Meals</td>
<td>14%</td>
</tr>
<tr>
<td>Desserts</td>
<td>13%</td>
</tr>
<tr>
<td>Non-Root Vegetables</td>
<td>9%</td>
</tr>
<tr>
<td>Instant Formula</td>
<td>6%</td>
</tr>
<tr>
<td>Cereal</td>
<td>4%</td>
</tr>
</tbody>
</table>

Mercury in Seafood

Salmonella Outbreak
CONSUMERS WANT TO KNOW ORIGIN, QUALITY OF THEIR FOOD
CONSUMERS WANT TO KNOW ORIGIN OF THEIR FOOD
Background

Summary: Traceability of FSCs

<table>
<thead>
<tr>
<th>REF</th>
<th>APPLICATION</th>
<th>BC TYPE</th>
<th>PRIVACY OF TRADE FLOWS</th>
<th>IMPLEMENTATION</th>
<th>SENSOR INTEGRATION</th>
<th>SCALABILITY</th>
<th>CONSUMER DATA ACCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>Agri-Food</td>
<td>public</td>
<td></td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>[2]</td>
<td>Agri-Food</td>
<td>public</td>
<td></td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>[4]</td>
<td>Fresh Food</td>
<td>------</td>
<td>------</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☒</td>
</tr>
</tbody>
</table>

- **Application:** Type of Food item
- **BC type:** Type of Blockchain, public, private, permissioned
- **Privacy of Trade Flows:** Every Participant is able to view, participate
- **Implementation:** Use of existing platforms such as Ethereum, Hyperledger, Multichain, HydraChain
- **Sensor Integration:** Integrating Sensor information
- **Scalability:** Business Model and integration to existing infrastructure
- **Consumer Trust:** Availability of Information to Consumer
Blockchain Solution?

• Emphasis on transparency
  • *story of “honest” products*

But:
• Who should we trust?
• Who should be allowed to maintain blockchain?
• Are there any access limitations?
• Scalability?
• Privacy Issues?
Identified Research Gaps

• **Understanding Role of Blockchain**
  • traditional systems, processes and mediators.
  • Fear of adoption of new technology
  • read/write/monitor data restrictions

• **Scalability of Blockchain**
  • Throughput, latency and capacity

• **Sensor Integration**
  • Blockchain -IoT sensor integration
  • regulatory objectives – e.g. transparency or accountability

• **Consumer Access to traceability information**
  • Origin of Food
  • Privacy issues- protecting trade flows
Identified Research Gaps

- **Understanding Role of Blockchain**
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**What is needed?** A hybrid Framework: consortium, permissioned blockchain and services to Consumer
Identified Research Gaps

Solution

• Understanding Role of Blockchain
  • discontent with traditional systems and mediators.
  • It is difficult to generalize public blockchain for business processes and complexities of supply chain.
  • Supply chain data restrictions as read/write/monitor.

• Scalability of Blockchain
  • Throughput, latency and capacity.

• Sensor Integration
  • Blockchain deficit of IoT sensor integration.
  • no Audit/Regulation of sensory information.

• Consumer Access to traceability information
  • Origin of Food.
  • Privacy issues- protecting trade flows.

Consortium of FSC participants, Governing Bodies

Network Architecture: Multiple Side Chains

Transaction Types, Sensor Values: Meta Data Audits by Regulatory

On shelf access through customized BC explorers
Blockchain for FSCs... Consortium
Blockchain for FSCs...
Tier 1: FSC Transaction Vocabulary

Create, Transfer, Produce
Blockchain for FSCs...

Tier 2: Block Validation

Diagram showing the process of block validation with steps:
1. PM submits Tx
2. Phase I: Verifies and Broadcast
3. Phase II: VI selection
4. Phase III: Verify and Broadcast Block
5. Phase IV: Commit to ledger

Steps:
- Claim leadership
- Primary validator verifies tx and broadcasts to validating peers
- VI with shortest wait time
- Verify sign, add to the new Block, sign the block, broadcast to validating peers
- Verify sign and commit to BCglob

Participants:
- FSC Client
- Validator 1
- Validator 2
- Validator 3 (2f+1)
- Global Validator
Blockchain for FSCs...

Tier 3: Customized Query Engine

• Provenance information:
  • location of origin of raw material, the name of primary

• Certification/Quality Checks:
  • Quality standards such as time/temperature measures in accordance with the
    food safety standards, for example in cold chain.

• Approved by FRA:
  • a consumer may only be interested if the production of food item met the
    standards and approved by food regulatory authority.
FSC Blockchain
Results

Provenance Information
Results...

Blockchain Size Vs Query Time

- A blockchain with an increasing product ledger size
- The query time product traceability
- Less than a traditional trace back method

Validating Transactions

- Base Case: A traditional DB
- BC: permissioned BC Create,
- Transfer Tx validation < 5ms
- Produce < 50 ms
Some Challenges

• Proving the quality of food
  • Types of food
• Accountability
• Organic Produce
• Disconnected chain
• Incentive for a low scale producer
• Privacy of Trade Flows

Blockchain cannot solve everything!
Thank you

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