Information Exchange in Global Logistics Chains: an application for Model-based Auditing

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Problems

- Risks in international trade are often considered from a company perspective, need a chain perspective.

- Supervision in international trade concentrates on the transportation of goods, data may be incomplete, wrong, unreadable, superficial ...

- Research Question: How can cargo data, collected from supply chain partners, be used to enhance regulatory compliance and control?
Supply Chain-Logistics-Transport Hierarchy

- **Global supply chain management**
  - Production, markets

- **Logistics management**
  - Storage or transportation

- **Transport operations**
  - Timing, mode choice, routing
• Is this your suitcase?

• Did you pack your suitcase yourself?

• Was the suitcase under your control at all times?

• Does the suitcase contain any dangerous items?
Solution?

We need new ways of finding check points in supply chains: chain approach + auditing techniques
Overview

Case study

Model-based Auditing

Quittance and Seals

Back to the case study
Mapping the chain: BAP Trade lanes in Living Lab

Trade lane: ABC – Yantian/Hong Kong to Felixstowe
Trade lane 1: ABC – Yantian/Hong Kong to Felixstowe

- Trade lane 1: ABC – Yantian/Hong Kong to Felixstowe
- Original 2-way match: count and purchase order
- Extended 2-way match: count and purchase order + penalty
- 3-way match: Purchase order, invoice and count
- 3-way match: Purchase order, invoice and count + penalty
- Milestones: SJ, GI, L2S, UfS, GO, EJ
- Cargo Services
- Allport (CS)
- BAP
- Empty depot
- trucking company
- consignee
- consignor
- supplier
Case Study
Descartes GLN manages data repository
YTN/HKG-FXT pipeline configuration

Diagram showing the pipeline configuration with nodes such as GLN (Descartes), DBS (BAP), EDISON (Cargo Services), LIMA (Allport), Customs Dashboard (IBM/Intrasoft), and Carrier system.
The piggy back principle

<table>
<thead>
<tr>
<th>Risks</th>
<th>Control measures</th>
<th>Residual risk</th>
<th>Government control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordered goods do not arrive</td>
<td>Three way match at consolidation warehouse</td>
<td>Fraud by own personnel</td>
<td>Verify personnel audit</td>
</tr>
<tr>
<td>Ordered goods do not arrive in time</td>
<td>Track shipments underway</td>
<td>Not relevant</td>
<td>none</td>
</tr>
<tr>
<td>Smuggling in regular flow</td>
<td>Stuffing in own consolidation center, with independent tally</td>
<td>FCLs that do not pass consolidation center</td>
<td>Focus on FCL shipments from non AEO parties</td>
</tr>
</tbody>
</table>
A more formal approach: model-based auditing

Treat business reality (transactions) as a value cycle: an interrelated system of flows of money and goods (Starreveld).

Model the value cycle as a series of events (decisions) and states (accounts), linked by value flows.

Use these relationships for verification and control (reconciliation)

Depending on the type of business, the relationship between the flow of money and the flow of goods is stronger or weaker:

- E.g. manufacturing (parts required) > services (billable hours)
- E.g. design ‘quasi goods’ to strengthen relationship
Model-based Auditing

Vendor

- purchase
  - accounts payable
  - money
  - pay
- inventory
- general ledger
- money
- collect
- sale
- goods
- delivery
- quittance
- reception
- purchase order
- accounts receivable
- accounts payable
- money
- invoice
- money
- collect
- €
- money
- rece

Client

- inventory
- general ledger
- pay
- money
- sale
Model-based Auditing

Two kinds of universal laws:

**Transformation**
(1) \( \text{input}(T, e) = f \cdot \text{output}(S, e) \), for some normative ratio \( f \).

**Preservation law: (NL: BETA formula)**
(2) \( S[t_1] = S[t_0] + \text{input}(S, [t_0, t_1]) - \text{output}(S, [t_0, t_1]) - \text{losses}(S, [t_0, t_1]) \)

**Conversion or aggregation laws:**
(1’) \( T \text{ in unit } u = f \cdot T \text{ in unit } v \), for \( f \) a normative conversion ratio.
Application to international trade

A: customs are informed about the goods by summary declaration, but this information is not always reliable

B: customs only have accurate information about the goods after full declaration

C: preferable to have accurate information about goods, at stuffing
Application to international trade

(3) value at export = value at import.


(5) goods underway = goods in pre-carriage + goods in terminal at origin + goods at sea + goods in terminal at destination + goods in on-carriage.

(12) total cargo weight of the container = box count • weight per box

(13) total number of items in the container = box count • number of items per box.
Quittance and seals

**Activity**: Reception of goods

**Primary actor**: Warehouse master (receiver)

**Secondary actor**: Truck driver (deliverer)

**Precondition**: Inventory \([t_0]\)

- Delivery agreement: quantity and quality of goods
- Some means to inspect quality and quantity of the goods.

**Postcondition**: Quittance. Declaration by warehouse master that quantity and quality of goods were delivered at time \(t_1\)

\[\text{Inventory} [t_1] = \text{Inventory} [t_0] + \text{Goods}\]

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[Diagram showing interaction between Truck Driver and Warehouse master]
### Quittance and seals

<table>
<thead>
<tr>
<th>Activity</th>
<th>Delivery of goods (dispatch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary actor</td>
<td>Truck driver (deliverer)</td>
</tr>
<tr>
<td>Secondary actor</td>
<td>Warehouse master (receiver)</td>
</tr>
<tr>
<td>Precondition</td>
<td>Truck load ([t0]), including the goods Delivery agreement: quantity and quality of Quittance: declaration by warehouse master that quantity and quality of goods were delivered at time (t1)</td>
</tr>
<tr>
<td>Postcondition</td>
<td>Truck load ([t1]) = Truck load ([t0]) – Goods</td>
</tr>
</tbody>
</table>

**Diagram:**

```
<table>
<thead>
<tr>
<th>Truck Driver</th>
<th>Agreement</th>
<th>Warehouse master</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ok?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quittance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dispatch</td>
<td></td>
</tr>
</tbody>
</table>
```
Unit of trade does not equal unit of transport:

(14) \( \text{goods on PO} = \text{goods on S/Os shipped} \ [t] + \text{goods on S/Os outstanding} \ [t] \) 
(15) \( \sum_i \text{goods on container manifest} [i] = \sum_j \text{goods on S/Os shipped} [j] \) 
(16) \( \sum_i \text{goods on S/Os shipped for vessel} \ [k] [j] = \sum_i \text{goods on carrier booking for vessel} \ [k] [i] \)
Case study

Many additional checks allow reliable tracing of the goods

Tally at Felixstowe
(17) box count on container manifest (stuffing)
    = tally by container handler (unloading)

Tally at stuffing
(18) box count container manifest (stuffing)
    = tally by freight forwarder (stuffing)

Role of local customs and customs broker
(19) Supplier identity, box count and product description upon arrival,
    by independent customs broker = goods and description on
    S/O for supplier $i$. 
What happens if supplier does stuffing

Trade lane 1: ABC – Yantian/Hong Kong to Felixstowe

- Empty depot
- SJ GIL2SUfSGOEJ
- Carrier trucking company
- Consignor
- Consignee
- Milestones
- FXT port
- BAP
- Allport (CS)
- Empty depot

Tally condition:
FCL volume > 55 cbm

Way match:
- Count, volume check and purchase order
- Volume < 55 cbm
- All documents contain weight above 55cbm

Precondition: FCL volume > 55 cbm

Extended 2-way match: count, volume check and purchase order + penalty

Volume < 55 cbm
Conclusions

Practical cases are complicated chains, including many different parties

Model based auditing provides the approach to find verification relationships in logistics chains

Approach is effective in real life case: need for further automation of the auditing process