AN ARCHITECTURE FOR SITUATION AWARE SMART LOGISTICS
M.E. IACOB, G. CHARISMADIPTYA, M.J. VAN SINDEREN, J.P.S. PIEST
PAPER PRESENTATION - 11TH SOEA4EE WORKSHOP
MOTIVATION
WHAT BROUGHT US HERE?

- Disruptions and exceptions are important risk sources in logistics
- Need for situation-aware information systems and decision making
- IoT is capable of real-time monitoring and exception detection
- Enhancing and linking IoT data with internal and external data sources
- Taking available knowledge and detection by users into account
APPROACH
DESIGN SCIENCE METHODOLOGY FOR INFORMATION SYSTEMS

- Problem investigation:
  - Structured literature review
  - Interviews with domain- and IT experts

- Treatment design:
  - Enterprise architecture modelling and engineering
  - Case study research
  - Prototyping

- Treatment validation:
  - Performance measurements
  - Expert opinion interviews
# PROBLEM INVESTIGATION

## REQUIREMENTS ELICITATION

<table>
<thead>
<tr>
<th>Slots</th>
<th>Roles</th>
<th>Stake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operator</td>
<td>Transportation manager (LSP)</td>
<td>Increase responsiveness to disruptions, reduce operational risks, guarantee SLAs to customers</td>
</tr>
<tr>
<td>Operational support</td>
<td>System integrator</td>
<td>Coherent and integrated IT architecture</td>
</tr>
<tr>
<td>Maintenance operator</td>
<td>System administrator</td>
<td>Software and hardware maintenance and configuration</td>
</tr>
<tr>
<td>Functional beneficiary</td>
<td>Customers</td>
<td>On time delivery of goods, order tracking &amp; immediate incident notifications</td>
</tr>
<tr>
<td>Regulator</td>
<td>Government</td>
<td>Implementation of/compliance to regulatory &amp; legal measures by design, e.g., GDPR</td>
</tr>
</tbody>
</table>

### Requirement

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agnostic data source integration</td>
<td>LSP, System integrator, System administrator, System administrator</td>
</tr>
<tr>
<td>Simple business processes</td>
<td>LSP, System integrator, System administrator</td>
</tr>
<tr>
<td>Aggregated and linked data usage</td>
<td>LSP, System integrator, System administrator</td>
</tr>
<tr>
<td>Nearly real-time detection</td>
<td>LSP, System integrator, System administrator</td>
</tr>
<tr>
<td>Information sharing</td>
<td>LSP (and other supply chain partners), customer, system integrator</td>
</tr>
<tr>
<td>Information security</td>
<td>LSP (and other supply chain partners), customer and government</td>
</tr>
</tbody>
</table>

Some of the route is not transparent

It is hard to traceback items affected by an exceptions

Slow response to exceptions

Improve traceability

Monitor exceptions events

Layered viewpoint:
- Business processes
- Application
- Technology

Detailed viewpoints:
- Exception management functions
- Case study for validation
- Information system prototype
TREATMENT DESIGN
SITUATION-AWARE SMART LOGISTICS ENTERPRISE ARCHITECTURE
TREATMENT DESIGN
SITUATION-AWARE SMART LOGISTICS ENTERPRISE ARCHITECTURE

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TREATMENT DESIGN
SITUATION-AWARE SMART LOGISTICS ENTERPRISE ARCHITECTURE

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TREATMENT DESIGN – DETAILS
BUSINESS PROCESS / DATA STRUCTURE VIEWPOINTS

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TREATMENT VALIDATION
CASE STUDY ‘FRESH AND FROZEN FOOD LOGISTICS’

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TREATMENT VALIDATION – DETAILS
CASE STUDY ‘FRESH AND FROZEN FOOD LOGISTICS’ / PROTOTYPING
TREATMENT VALIDATION – DETAILS
CASE STUDY ‘FRESH AND FROZEN FOOD LOGISTICS’ / PROTOTYPING

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TREATMENT VALIDATION - CONTINUED
PROTOTYPING USING MODEL DRIVEN DEVELOPMENT PLATFORMS

Screenshots of the prototype built in Mendix:
https://situationawarelogi100.mxapps.io/login.html
## Stakeholder Requirement realization Requirement Opinion Score

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Requirement realization</th>
<th>Requirement</th>
<th>Opinion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation manager</td>
<td>Monitor Exception Occurrence</td>
<td>Agnostic data source integration Near real-time exception detection</td>
<td>+ Sensor gives the user more information about the condition surrounding the items + The rule-based system is extensible. The rule for the new item can be added quite easily. + The rules can be adjusted on the fly. Useful to adjusting the sensitivity. + The notifications are sorted by importance and provide necessary information to act upon - There is no well-tested rule currently available to use. - The current prototype does not have a function to mark the notification as read / handled</td>
<td>4</td>
</tr>
<tr>
<td>Improve Traceability</td>
<td>Information augmentation Information sharing</td>
<td></td>
<td>+ The sensor provides real-time &amp; location of an item. It may be useful for deciding mitigation operation - On the road, the system tracked the items on the pallet level. An item can be removed from the pallet on the way, untraced.</td>
<td>4</td>
</tr>
<tr>
<td>Customers</td>
<td>Timely exception notifications</td>
<td>Near real-time exception detection Information augmentation</td>
<td>+ The exception detection working as intended + The exception notification provide information about the affected customer. - No 3rd party data is currently available to enhance the detection capabilities</td>
<td>4</td>
</tr>
<tr>
<td>Monitor items conditions</td>
<td>Information Sharing</td>
<td></td>
<td>+ The exception notification provides enough information about the affected customer. + The Industrial dataspace provides 3rd party information that can enhance the information surrounding the exception - Information security audit is a complicated process. - Information data space is hard to set up</td>
<td>4</td>
</tr>
<tr>
<td>The government</td>
<td>Adhere to security &amp; privacy laws</td>
<td>Information Security</td>
<td>+ The role-based access limits well what the user can view. Only privileged roles can access private information such as customer information. - Complex information audit process</td>
<td>2</td>
</tr>
<tr>
<td>System designer</td>
<td>Simple to implement &amp; updates</td>
<td>Simple Business Process</td>
<td>+ The system module satisfies the stakeholder’s need</td>
<td>4</td>
</tr>
<tr>
<td>System Implementer</td>
<td>Easy to learn</td>
<td>Simple Business process</td>
<td>+ The navigation of the user interface follows the design principles and is clear - Some of the user interfaces are too crowded with data</td>
<td>3</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>3.57</strong></td>
</tr>
</tbody>
</table>
CONCLUSION
WHERE ARE WE NOW?

- Design of a situation-aware smart logistics enterprise architecture
- ArchiMate specification of six requirements
- Development and deployment of prototype information system
- Usage of IoT event data, incl. position and temperature
- Case study research in fresh and frozen food logistics
- Collected data about usability and performance with experiments

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LIMITATIONS
BOUNDARIES OF EXPERIMENTS AND VALIDITY

- **Experiments and tests:**
  - Synthetic event data
  - Limited systems integration
  - No IDS implementation

- **Scope of validation:**
  - Single scenario
  - Functionality tested in lab environment
  - Limited amount of tests
FUTURE WORK
WHAT ARE THE NEXT STEPS FORWARD?

- More validation experiments and testing in real-life situations:
  - More complex multi-actor business processes in logistics
  - Systems integration for real-time data streaming from IoT / IDS
- Improve functionality and usability of the architecture:
  - Storage of historical data for data analytics
  - Connectors for ERP integration and APIs for third parties
- Incorporation of artificial intelligence:
  - Capture additional ‘situational data’: vision, sound, shock, …
  - Usage of machine learning and deep learning techniques
  - Enhanced decision making based on intelligence amplification
EXTENSION
TRANSFER RESULT TO DATAREL RESEARCH PROJECT CONTEXT

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10/30/2019
DISCUSSION
PLEASE SHARE YOUR THOUGHTS AND ASK YOUR QUESTIONS
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