Systematic Analysis of IT Complexity Challenges
Hindering the Implementation of Industrie 4.0 Roadmaps
ICIMP 2019

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Motivation: Digital, agile businesses outperform traditional businesses because of lower latencies in the entire reaction chain.

Typical reaction of traditional companies to unplanned event:
- Event
- Insights about event become available
- Analysis completed
- (Counter-)measure approved
- (Counter-)measure takes effect
- Value of adaptation

Typical reaction of agile companies to unplanned event:
- Event
- (Counter-)measure takes effect
- Value of adaptation

Drivers of Industrie 4.0:
- Real-time capability
- Systems integration
- Big Data Analytics
- Machine Learning and Artificial Intelligence
- Decision support systems
- Automated decision making
- Vertical and horizontal process and systems integration
- Cyber-physical systems

Companies become faster and more agile with Industrie 4.0.
Motivation: *acatech Industrie 4.0 Maturity Index enables a systematic development of manufacturing companies*

Automated data acquisition
Decentralised (pre-)processing data
Task-based interface design
Efficient communication
Digital competencies

Agile management
Flexible communities
Motivational goal systems
Focus on customer benefits
Decision rights management

Horizontal and vertical integration
Application-specific user interfaces
Contextualised data delivery
Resilient IT infrastructure
Data analysis

Open communication
Openness to innovation
Continuous professional development
Data-based learning and decision-making
Confidence in processes and IT-systems

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Source: SCHUH ET AL. 2017, P. 19
Hypothesis: IT complexity challenges are hindering the implementation of Industrie 4.0 roadmaps significantly

IT complexity in practice

“IT complexity will soon make it impossible to effectively control digital performance.”

“66% of IT employees fear to be overwhelmed due to increasing IT complexity.”

“44% of companies do not keep their internal digital processes under surveillance. 15% say it’s due to the high complexity of their IT landscape.”

Dimensions of IT complexity

**Uncertain dynamics**

- **Interdependent variety**
  - **Simple systems**
  - **Complicated systems**
  - **Relatively complex systems**
  - **Highly complex systems**

**Diffuse perception**

- **Low**
- **Medium**
- **High**
- **Clear**
Approach: Real-life data from 12 companies gathered in Industrie 4.0 Roadmap projects were systematically analyzed

Gathered data of 12 companies assessing 55 core processes

Determination of IT complexity relevant Industrie 4.0 capabilities

Data analysis regarding relationship between IT complexity and Industrie 4.0

The approach ensures a systematic analysis of real-life data from manufacturing companies to determine if IT complexity is a significant obstacle in reaching a higher Industrie 4.0 maturity level.
Results: In 4 out of 5 analyzed core processes IT complexity is a statistically significant obstacle for a higher Industrie 4.0 maturity level

- 55 processes analyzed: planning & scheduling (7), manufacturing & assembly (21), maintenance (5), logistics (9), quality management (8), sales (1), service (2), tool-shop (2)
- A linear correlation between IT complexity capabilities and the overall maturity level of a company could be shown by a Pearson Product Moment correlation of r=0.85 (model fit 72%, r²=72)
- Within main processes Student’s T-Test shows statistically significantly lower mean of the Industrie 4.0 maturity for those capabilities relevant for IT complexity, exception is logistics

Scatter Plot of all processes

Maturity stage’s average per main process

Results:
Interpretation: Manufacturing companies have to invest in their management of IT complexity to successfully implement Industrie 4.0

### IT complexity relevant capabilities with the lowest overall mean value

<table>
<thead>
<tr>
<th>Capability</th>
<th>Mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilience (stability of IT system operations)</td>
<td>1.44</td>
</tr>
<tr>
<td>Data model (model of all data relevant to the company)</td>
<td>1.51</td>
</tr>
<tr>
<td>Data storage (centrality and redundancy of data storage)</td>
<td>1.58</td>
</tr>
<tr>
<td>User interface (ease of use and changeability of user interfaces)</td>
<td>1.67</td>
</tr>
<tr>
<td>Vertical integration (integration between IT systems of different levels)</td>
<td>1.73</td>
</tr>
</tbody>
</table>

**Resilience** – Companies need to increase redundancy and therefore operational stability of IT systems. This also includes a comprehensible documentation of the system’s configuration as well as a risk analysis of potential failures.

**Data model** – Companies need to develop one core data model containing all relevant data points assigned to the IT systems used and the business processes supported.

**Data storage** – As foundation for data driven process optimization as well as data driven services, a central and redundant data storage is necessary. Companies can realize this e.g. by implementing a data warehouse.

**User interface** – As employees of a company are used to easy-to-use smartphones, simple, structured and tailored user interfaces are important to support the employees in using the company’s IT systems.

**Vertical integration** – A single source of truth for all information relevant to the core business processes needs to be created. Information is stored redundancy-free and easy to access for all employees involved in the business process.
Thank you very much for your attention!

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References


