A COMPREHENSIVE TYPOLOGY OF COMPLEX SC RISK NETWORKS USING A DATA DRIVEN APPROACH

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Agenda

- Assess risk (and resilience) in Industry 4.0 setting
- Describe an exploratory research project
- Develop an Enterprise Risk Management typology

Overarching Objective

Develop an empirical research agenda related to Enterprise Risk Management
Why Complex Adaptive System Network?

- Trade agreements
- War
- Pandemic
- Social trends
- International law
- Cyber threats

COMPLEX ADAPTIVE SYSTEMS
A broader view of potential risks and interconnections is foundational to understand the adaptive dynamics.

A comprehensive risk typology will ground risk profile-performance relationships better towards empirical advancement.
A Comprehensive Enterprise Risk Typology

**Data sources**
- Public 10-k’s
- Commercial reports

**Data Mining**
- Text mining using heuristics
- Seed-expansion using author reported keywords

**Organization**
- Value framework
- Categorization

**Risk Typology**

<table>
<thead>
<tr>
<th>Level</th>
<th>Number</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8</td>
<td>Manage Value</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>Governance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business strategy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corporate growth</td>
</tr>
<tr>
<td>2</td>
<td>54</td>
<td>shareholder welfare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>financial reporting</td>
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<tr>
<td></td>
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<td>product portfolio</td>
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<tr>
<td></td>
<td></td>
<td>strategic execution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strategic alliances</td>
</tr>
<tr>
<td>3</td>
<td>685</td>
<td>repositioning risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>launch uncertainty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R&amp;D conversion</td>
</tr>
</tbody>
</table>

**Source:** Sheth A, Sinfield JV. 2021 (under-review) MIT Sloan Management Review

~700 non-unique risk factors

**Value Framework**

- Protect Value
- Deliver Value
- Capture Value
- Manage Value
- Risk
- Create Value
- Convey Value
- Identify Value
- Sustain Value

**Risk Typology**

- Protect Value
- Deliver Value
- Capture Value
- Manage Value
- Risk
- Create Value
- Convey Value
- Identify Value
- Sustain Value
As a next step:
Seeking expert opinion on classifying ~130 operations risk factors in order to convert the typology tree structure into a lattice network structure.
## The Typology Acts As A Resource For Enterprise Risk Studies

<table>
<thead>
<tr>
<th>Level 1*</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
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</thead>
<tbody>
<tr>
<td><strong>Risk Typology</strong></td>
<td><strong>Capture Value</strong></td>
<td><strong>Convey Value</strong></td>
<td><strong>Create Value</strong></td>
<td><strong>Operational Capability</strong></td>
</tr>
<tr>
<td><strong>Capture Value</strong></td>
<td><strong>Convey Value</strong></td>
<td><strong>Create Value</strong></td>
<td><strong>Operational Capability</strong></td>
<td><strong>Facilities and processes</strong></td>
</tr>
<tr>
<td><strong>Convey Value</strong></td>
<td><strong>Create Value</strong></td>
<td><strong>Operational Capability</strong></td>
<td><strong>Business interruption risk</strong></td>
<td><strong>Business interruption risk</strong></td>
</tr>
<tr>
<td><strong>Create Value</strong></td>
<td><strong>Operational Capability</strong></td>
<td><strong>Facilities and processes</strong></td>
<td><strong>Business process implementation risk</strong></td>
<td><strong>Business interruption risk</strong></td>
</tr>
<tr>
<td><strong>Operational Capability</strong></td>
<td><strong>Facilities and processes</strong></td>
<td><strong>Business interruption insurance premia risk</strong></td>
<td><strong>Manufacturing competence risk</strong></td>
<td><strong>Business interruption insurance premia risk</strong></td>
</tr>
<tr>
<td><strong>Business interruption risk</strong></td>
<td><strong>Regulatory interruption</strong></td>
<td><strong>Business process implementation risk</strong></td>
<td><strong>Manufacturing competence risk</strong></td>
<td><strong>Business interruption insurance premia risk</strong></td>
</tr>
<tr>
<td><strong>Business interruption insurance premia risk</strong></td>
<td><strong>Reduced response time risk</strong></td>
<td><strong>Manufacturing competence risk</strong></td>
<td><strong>Claims costs risk</strong></td>
<td><strong>Reduced response time risk</strong></td>
</tr>
</tbody>
</table>

* Source for Level 1:
Jucun Liu, Tony W. Tong, Joseph V. Sinfield.
Toward a resilient complex adaptive system view of business models,
Long Range Planning, 2020
Converting Risk Typology Into Complex Risk Networks *

Data mining and text analysis (AI tools)

Survey and Semi-structured interviews

Fuzzy Cognitive Mapping

Comprehensive typology

Conceptual relationships

Complex network analyses

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Co-PI² – Ananya Sheth

¹ Professor, Civil Engineering, Purdue University
² Doctoral Candidate, Civil Engineering, Purdue University
A broader view of potential risks can help develop a better understanding of interconnections.

A comprehensive risk typology can help ground risk profile-performance relationships better.

### An Organizing Schema For Empirical Research

**Source:** Sheth A, Sinfield JV. 2021 (in-review). “A simple framework to organize enterprise risks”, Journal of Risk Research

<table>
<thead>
<tr>
<th>Permanence of the induced change</th>
<th>Frequency of occurrence</th>
<th>Scope of the impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>How permanent is the change it causes?</td>
<td>How frequent and therefore, uncertain / predictable is it?</td>
<td>How far reaching is its impact? Which stakeholders are affected?</td>
</tr>
<tr>
<td>• Permanent</td>
<td>• Regular / predictable</td>
<td>• Intra-firm</td>
</tr>
<tr>
<td>• Reversible</td>
<td>• Irregular / estimable</td>
<td>• Inter-firm</td>
</tr>
<tr>
<td>• Temporary</td>
<td>• Unexampled / imaginable</td>
<td>• Intra-industry</td>
</tr>
</tbody>
</table>

**Dependent Variable**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Unit of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational performance</td>
<td>Firm</td>
</tr>
<tr>
<td>Financial performance</td>
<td>Firm, Industry</td>
</tr>
<tr>
<td>Growth &amp; Innovation</td>
<td>Firm, Industry</td>
</tr>
</tbody>
</table>
## Research And Teaching Programs Going Forward

### Research

**Overarching / Contingency View**
- Empirically examine firm risk and growth (innovation, BM choices)
- Empirically examine risk and industry operational characteristics

**Configurational / Holistic View**
- Model to identify highly centralized and distributed risks
- Examine performance impact of cascading effect of specific events

### Teaching

**Overarching / Contingency View**
- Strategy and organizational design choices
- Actionable risk management via the contingency view

**Configurational / Holistic View**
- Machine Learning applications in business management
- Power and limitations of automated systems
THANK YOU

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