



A Researcher's Perspective on Supply Chain Risk

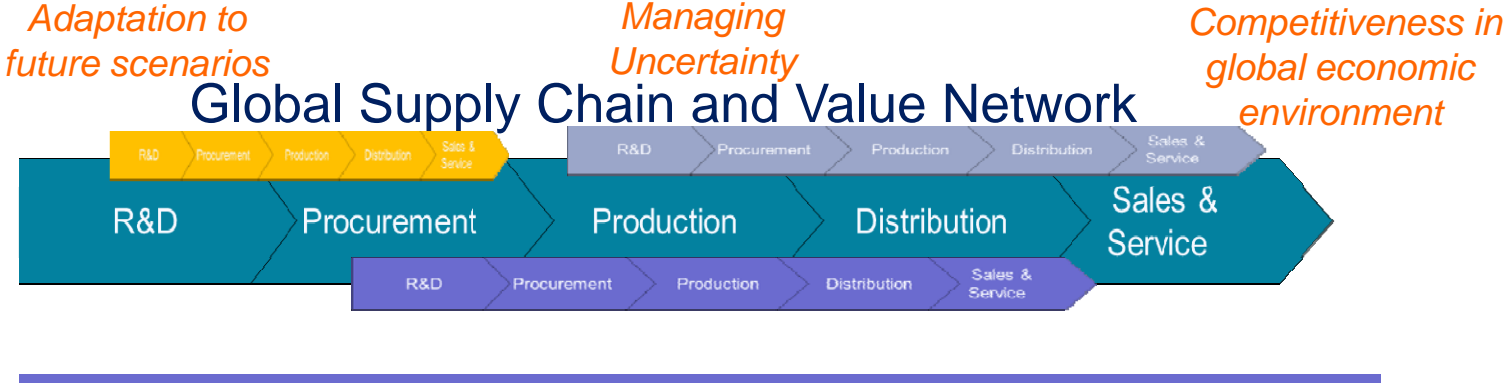
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Landscape of Industrial Challenges



Skills & Platform Technology

Use green technology and produce low waste



Availability, accessibility, financial feasibility ?

Materials and Resources

Use less resources



Restrictive Material and Substances

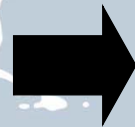
The world is changing ...

Original Equipment Manufacturers

- ...Vertical Integration Vs. **Specialisation**
- ...Integral Products Vs. **Modular assembly**
- ...Centralised Vs. **Dispersed**...

Environment is unpredictable

- Black Swans** occur
- ... political instability and **economic crises**
- ... customers increasingly globally aware
- ... **competition** for global resources, **scarcity** of materials (access/availability)
- ...frequency of external events- **terrorism & natural disasters**



Implications for the future

- ... **Value chains** are increasingly **fragmented** and **complex**
- ... **competition between global supply chains**
- ... managing **uncertainty** is a key requirement
- ...emergence of **new business models**



Changing technology landscape

- ... **disruptive technologies** spanning product groups
- ... alternative **production processes**
- ... Shorter **product life cycles**



Suppliers & Subcontractors

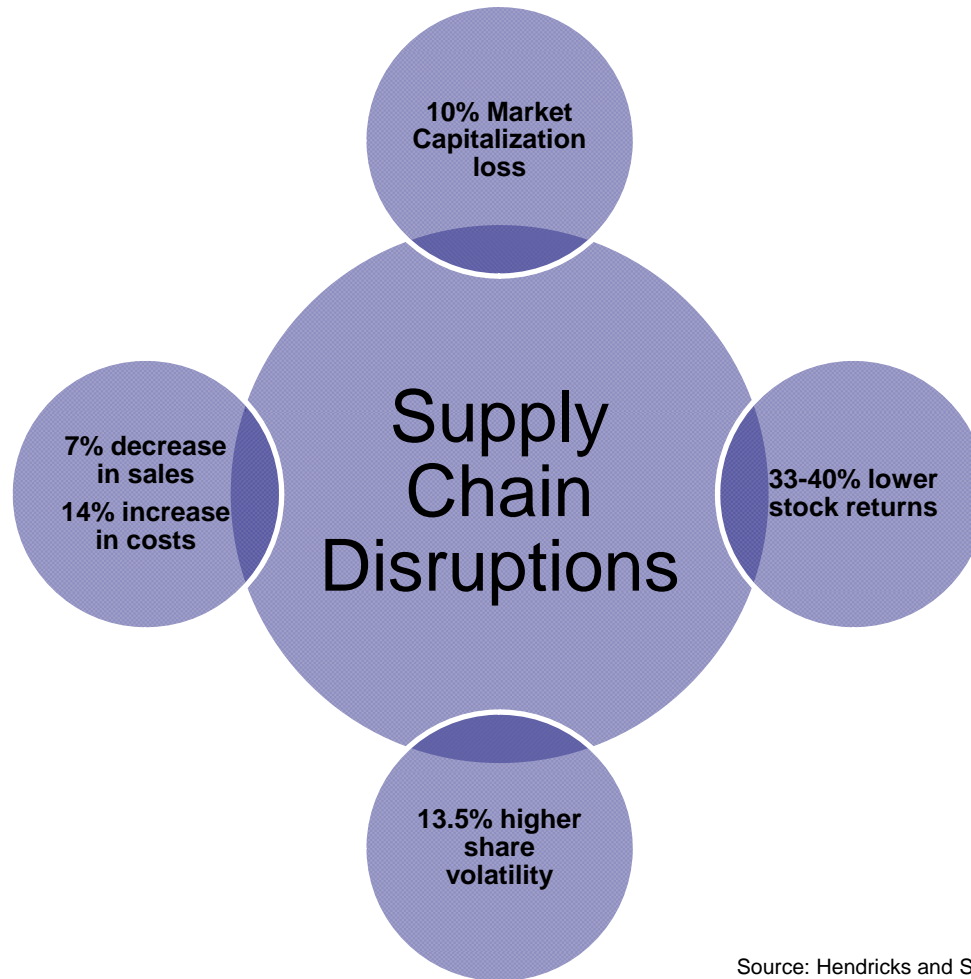
- ... Increasing **dependence on contract manufacturers** and **global suppliers**
- ... are **involved in product development**
- ... **risk sharing**



Examples of supply chain risks

Year	Company affected	Cause	Consequences
2011-2012	Western Digital, Dell	Thailand flood	a 3.8 million-unit shortfall in PC shipments in the first quarter of 2012, due to hard disk drive shortage
2011	Honda, Toyota, GM...	Japanese tsunami and earthquake	Honda cut production at its UK factory by 50% for seven weeks, while three Nissan plants in the US shut down completely. 3.6m units lost from global vehicle production 2011
2010	BMW and Nissan	Volcanic eruption (Iceland)	Delayed production at three BMW plants in Germany because of shortages of electrical components affecting 7,000 vehicles
2008	Volvo	Currency fluctuations: weak dollar	28% reduction of sales compared with the same period in previous years with a 50% reduction for its SUV
2003	American companies	Grid blackout in the northeast of the USA	Significant disruptions in the supply chain
2002	NASA and Ford	"love Bug" computer virus	The virus shut down email at the Pentagon, NASA and Ford causing billions of dollars in estimated damages.
2001	Toyota & Ford	Terrorist attacks against the World Trade Centre	Automotive Parts were blocked at the Canadian border leading to production stoppage
2001	Land Rover	Supplier (UPF-Thompson) bankruptcy	The Discovery production line was shut down for a couple of months
2000	Nokia and Sony Ericsson	Fire in a Philips semiconductor factory	\$400 million loss for Sony Ericsson when it became clear that the production would be compromised for months, Ericsson faced a serious shortage of critical parts
1999	Apple	Taiwan earthquake	DRAM chips shortage , since most suppliers were located around the same location and faced disruption due to the earthquake.

Supply Chain Risk - Potential Consequences

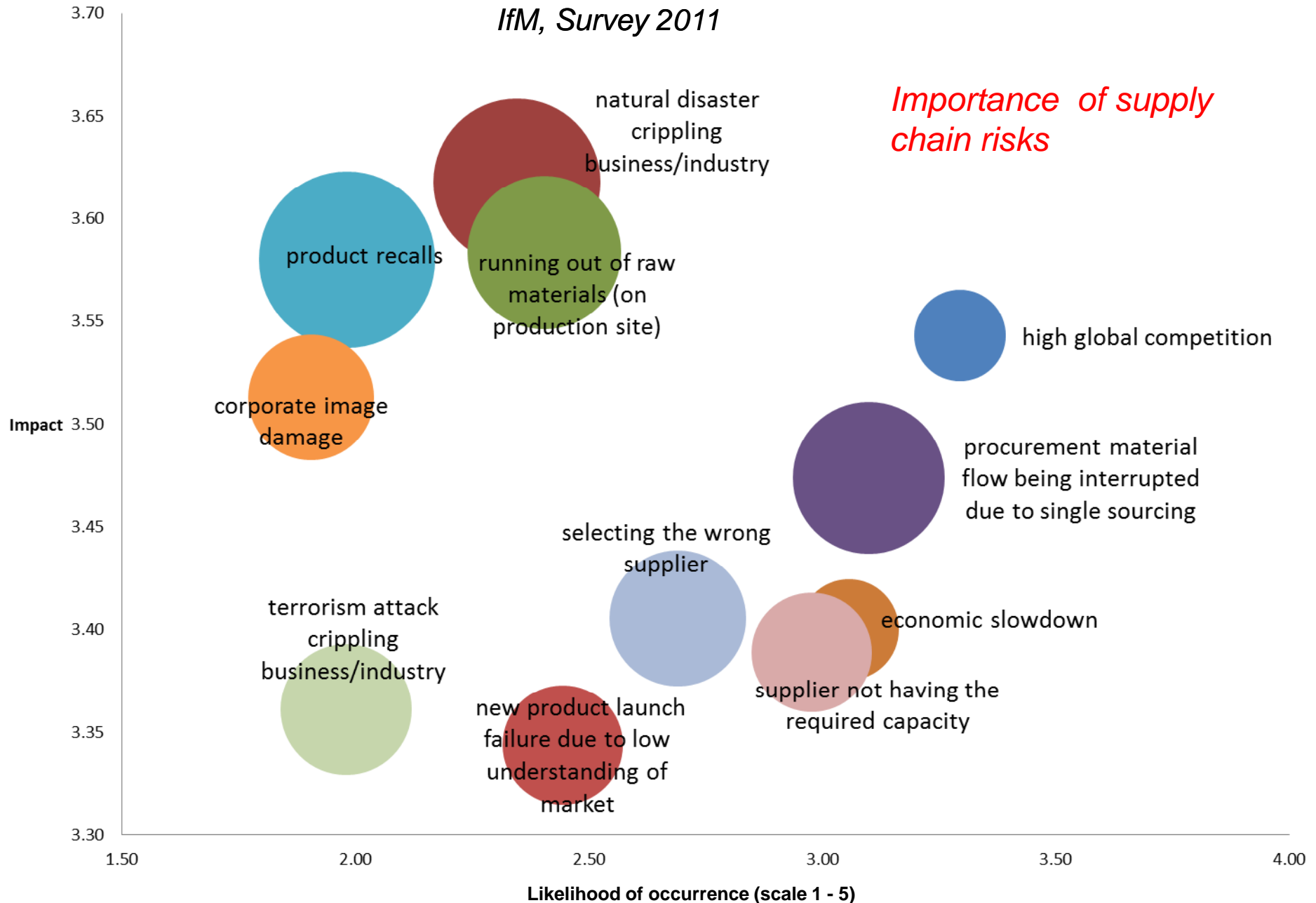


Source: Hendricks and Singhal 2005, Bosman 2006, Olson 2004

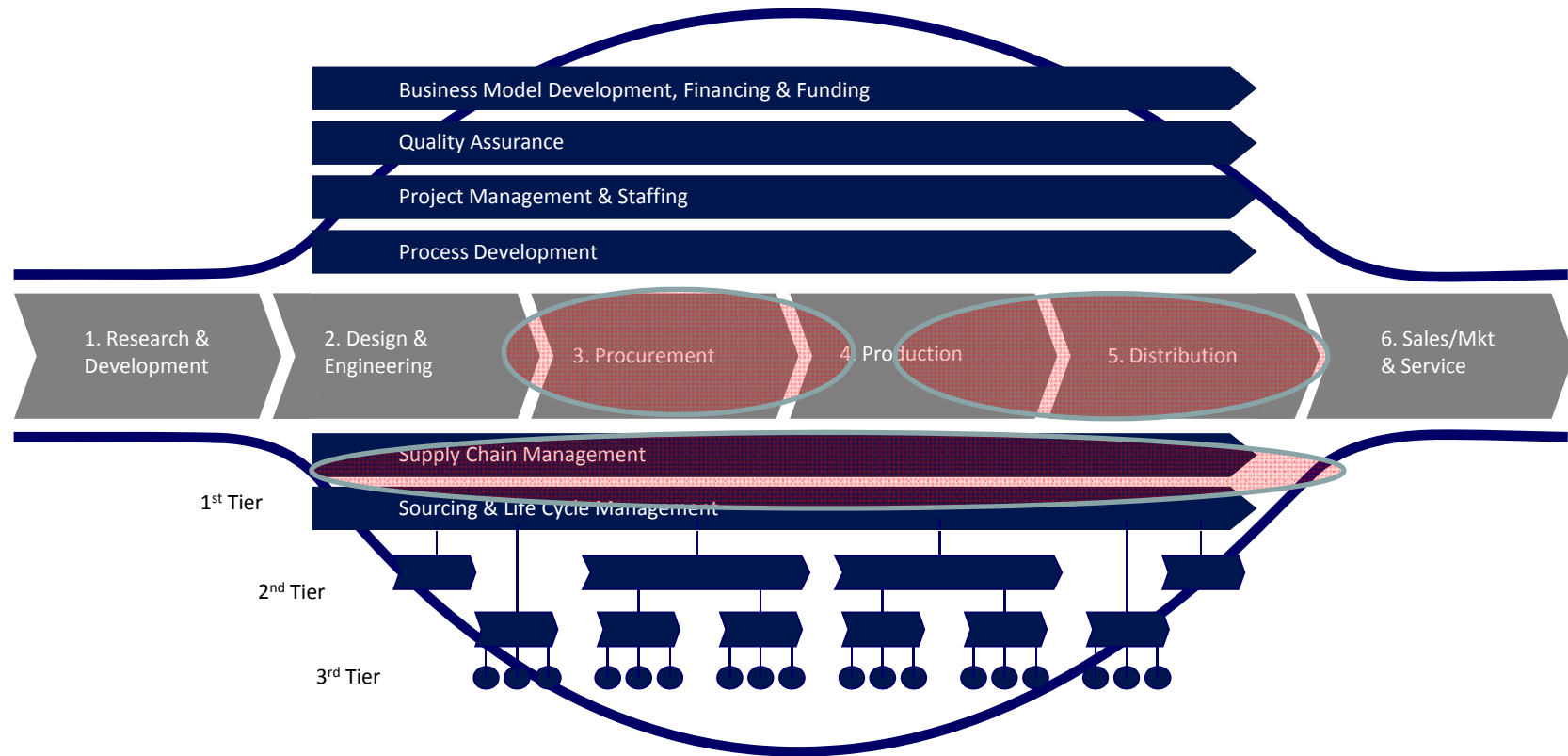
Top 12 Industrial risks out of 168 risks (w/o R&D activities)

IfM, Survey 2011

Importance of supply chain risks



A Typical Supply Chain – Narrow View of Risk Exposure



Risk Management: Process Maturity

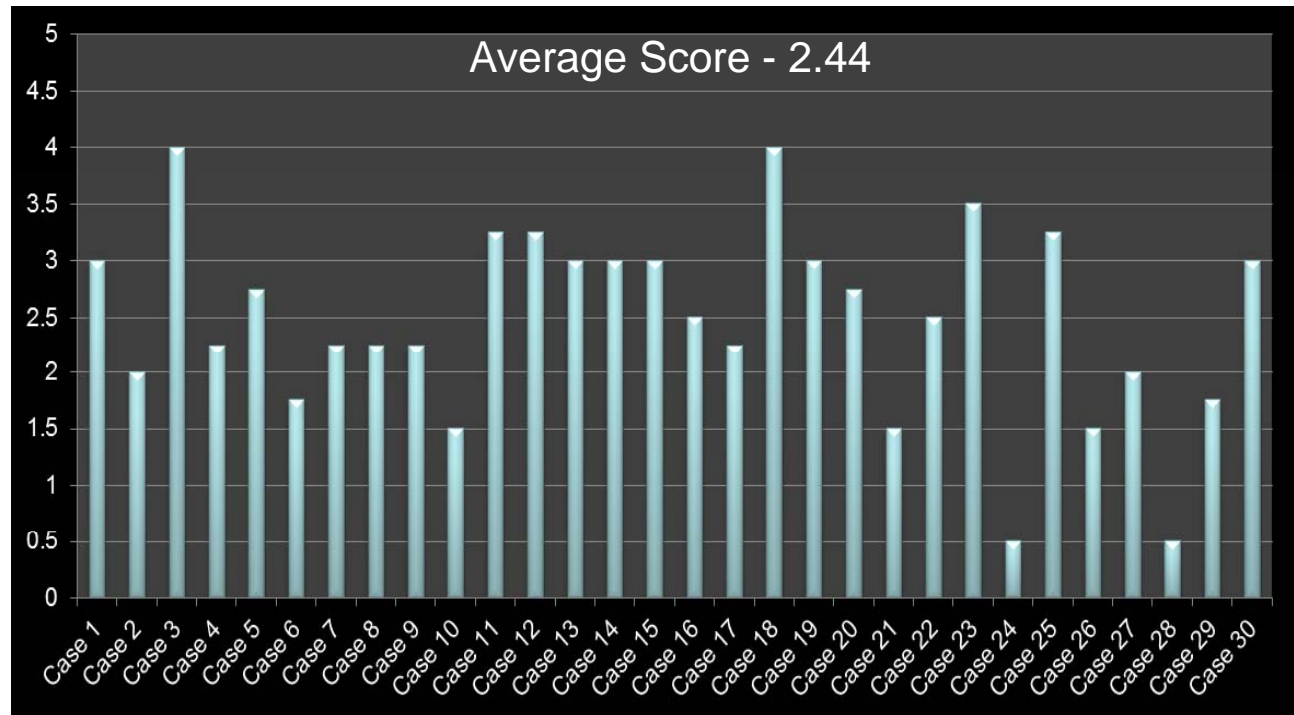
Maturity Model combines notions of evolution with levels of process formality, emphasising effectiveness and repeatability

-External and internal risks sources considered in maturity mapping

Maturity Capability	Accidental/ Initial 1	Repeatable - 2	Defined 3	Manage 4	Mastered/ Optimised 5
Risk Management	No formal risk assessments made	Internal Risks identified thru a formal process	Network Risks identified thru a formal process	Network Risks managed routinely	SC & Product/Service offering redesigned to offset key risks

Case Study: Investigation into SCN Risk Management Capabilities

Maturity Capability	Accidental/ Initial 1	Repeatable - 2	Defined 3	Manage 4	Mastered/ Optimised 5
Risk Management	No formal risk assessments made	Internal Risks identified thru a formal process	Network Risks identified thru a formal process	Network Risks managed routinely	SC & Product/ Service offering redesigned to offset key risks



Mfg companies lack a systematic approach to identify, assess, administrate and monitor risks

Tools for Practitioners

Industrial Investment Risk Management

- Based on PhD research
- Developed through a Industrial Partner

Supply Chain Network Risk Management

- Based on previous RM tool
- Key factors derived from Industrial Survey
- Currently in testing phase

Practical Approach

1. Identify Changes Resulting from Network
 - List of generic changes / characteristics prompts
 - Identification of specific changes/ value characteristics

2. Identify Risks Resulting from Changes / SC Characteristics
 - List of generic risks prompts
 - Identification of specific risks
 - Quantification of risk exposure
 - impact and probability

3. Identify Mitigation for More Serious Risks
 - Identification of specific mitigation (may include additional projects) in terms of
 - Resources, timing, costs and impact on return
 - List of generic mitigation types

Investment risk: implemented by leading multinational

- Risk identification
- Risk assessment

Project Risk Identification			
Project Name	Project Manager	Project Start	Project End
<p>Context</p> <p>Market</p> <p>Does the project exist?</p> <p>Does the product exist?</p> <p>Will the project exist?</p> <p>Will the project succeed?</p> <p>Competition</p> <p>Will the project exist?</p> <p>Will the project succeed?</p> <p>Suppliers & Inbound</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Production - Machine Level</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Production - Plant Level</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Production - Network Level</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Outbound & Customers</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>People & Skills</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Platform Technology</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Business Process</p> <p>Does the project exist?</p> <p>Will the project succeed?</p> <p>Project Execution</p>			



- Risk mitigation

Part 1: Risk Assessment and Mitigation											
Risk ID	Description	Category	Impact	Probability	Score	Owner	When	How	Linkages	Other	Overall
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Total risk score after mitigation											1512%

- Ownership & Accountability

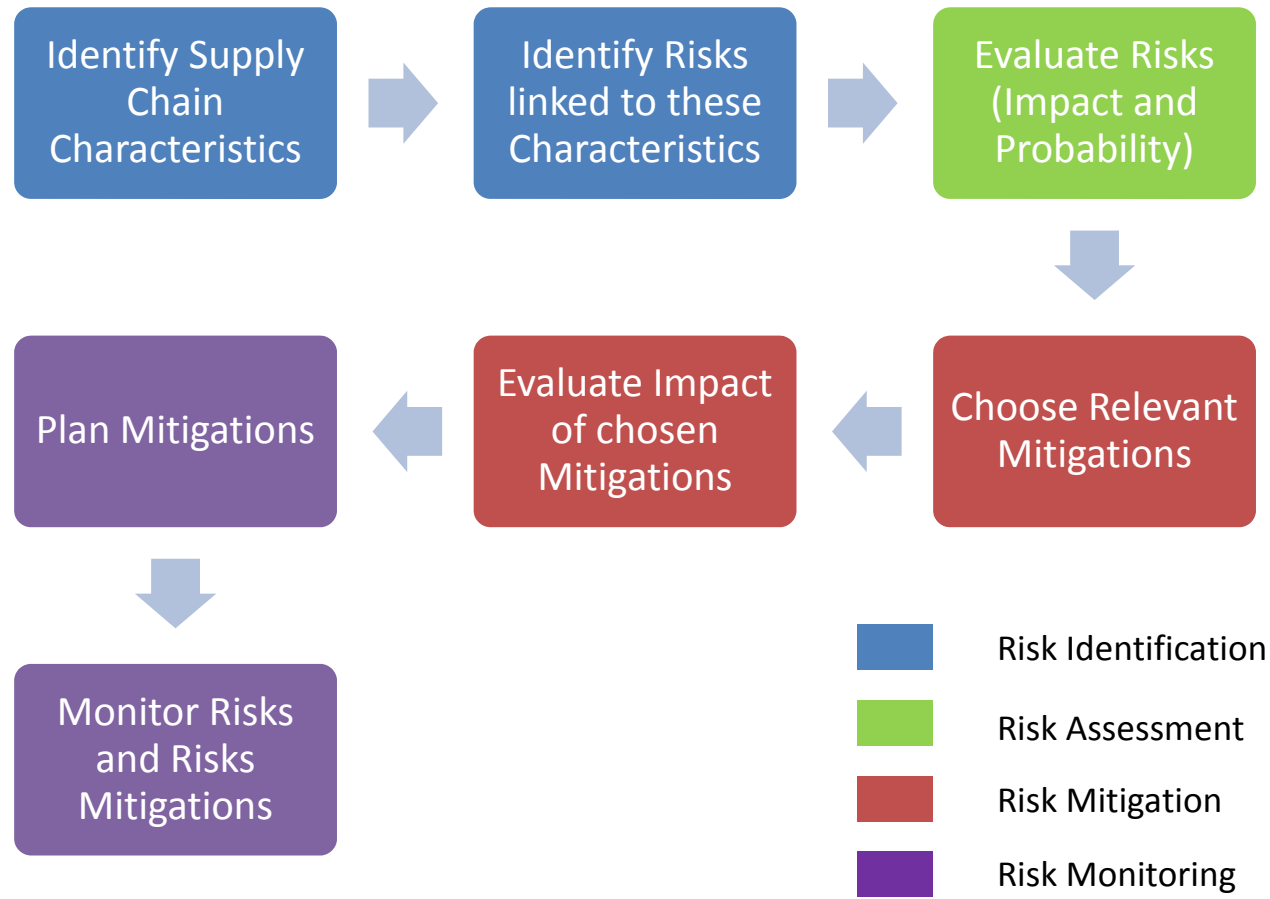
- Monitoring

Conclusions	
Summary of key risks	Description
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total risk score	3022%
Total risk score after mitigation	1512%

Action Plan	What	Who	When	Linkages with other projects
1>Action 1				
2>Action 2				
3>Action 3				
4>Action 4				
5>Action 5				
6>Action 6				
7>Action 7				
8>Action 8				
9>Action 9				
10>Action 10				

Context	Project 1	Project 2	Project 3	Project 4
Market	0%	0%	0%	0%
Product	0%	0%	0%	0%
Competition	0%	0%	0%	0%
Legislation/government/Finance/Corporation	0%	0%	0%	0%
Configuration				
Suppliers & Inbound	0%	0%	0%	0%
Production - machine level	0%	0%	0%	0%
Production - plant level	0%	0%	0%	0%
Production - network level	0%	0%	0%	0%
Outbound & customers	0%	0%	0%	0%
Capability				
People & skills	0%	0%	0%	0%
Platform technology	0%	0%	0%	0%
Business process	0%	0%	0%	0%
Project management	0%	0%	0%	0%

A Supply Chain Risk Management Framework



Supply Chain Focus: testing with leading multinationals

- Risk identification
- Risk assessment

Supply Chain Stage	Risk Category	Sub-category	Impact	Frequency	Severity	Overall Risk Score	Notes
Raw Materials	Supply Chain	Raw material availability	High	Medium	High	18	
		Raw material quality	Medium	Low	Medium	6	
		Raw material cost	Low	High	Low	3	
	Logistics	Logistics reliability	Medium	Medium	Medium	9	
		Logistics cost	Low	High	Low	3	
		Logistics security	Medium	Low	Medium	6	
Manufacturing	Production	Production efficiency	Medium	Medium	Medium	9	
		Production quality	Medium	Low	Medium	6	
		Production cost	Low	High	Low	3	
	Maintenance	Maintenance reliability	Medium	Medium	Medium	9	
		Maintenance cost	Low	High	Low	3	
		Maintenance safety	Medium	Low	Medium	6	
Distribution	Inventory	Inventory management	Medium	Medium	Medium	9	
		Inventory cost	Low	High	Low	3	
		Inventory security	Medium	Low	Medium	6	
	Logistics	Logistics reliability	Medium	Medium	Medium	9	
		Logistics cost	Low	High	Low	3	
		Logistics security	Medium	Low	Medium	6	



- Risk mitigation

Risk ID	Description	Current Risk Score	Target Risk Score	Mitigation Strategy	Responsible Party	Start Date	End Date	Status
1	Raw material availability	18	12	Diversify suppliers	Procurement	2023-01-01	2023-03-31	In Progress
2	Raw material quality	6	4	Implement quality control	Production	2023-01-01	2023-02-28	Completed
3	Raw material cost	3	2	Long-term contracts	Procurement	2023-01-01	2023-06-30	In Progress
4	Logistics reliability	9	6	Use multiple carriers	Logistics	2023-01-01	2023-04-30	In Progress
5	Logistics cost	3	2	Optimize routes	Logistics	2023-01-01	2023-05-31	In Progress
6	Logistics security	6	4	Enhance security measures	Logistics	2023-01-01	2023-07-31	In Progress
7	Production efficiency	9	7	Automate processes	Production	2023-01-01	2023-09-30	In Progress
8	Production quality	6	4	Invest in training	Production	2023-01-01	2023-08-31	In Progress
9	Production cost	3	2	Reduce waste	Production	2023-01-01	2023-10-31	In Progress
10	Maintenance reliability	9	7	Preventive maintenance	Maintenance	2023-01-01	2023-11-30	In Progress
11	Maintenance cost	3	2	Energy-efficient equipment	Maintenance	2023-01-01	2024-01-31	In Progress
12	Maintenance safety	6	4	Safety training	Maintenance	2023-01-01	2024-02-28	In Progress
13	Inventory management	9	7	Just-in-time inventory	Inventory	2023-01-01	2024-03-31	In Progress
14	Inventory cost	3	2	Reduce stock levels	Inventory	2023-01-01	2024-04-30	In Progress
15	Inventory security	6	4	Physical security	Inventory	2023-01-01	2024-05-31	In Progress
16	Logistics reliability	9	7	Real-time tracking	Logistics	2023-01-01	2024-06-30	In Progress
17	Logistics cost	3	2	Consolidate shipments	Logistics	2023-01-01	2024-07-31	In Progress
18	Logistics security	6	4	Secure packaging	Logistics	2023-01-01	2024-08-31	In Progress
19	Production efficiency	9	7	Lean manufacturing	Production	2023-01-01	2024-09-30	In Progress
20	Production quality	6	4	Statistical process control	Production	2023-01-01	2024-10-31	In Progress
21	Production cost	3	2	Value engineering	Production	2023-01-01	2024-11-30	In Progress
22	Maintenance reliability	9	7	Condition-based monitoring	Maintenance	2023-01-01	2025-01-31	In Progress
23	Maintenance cost	3	2	Energy audits	Maintenance	2023-01-01	2025-02-28	In Progress
24	Maintenance safety	6	4	Lockout/tagout procedures	Maintenance	2023-01-01	2025-03-31	In Progress
25	Inventory management	9	7	Inventory optimization	Inventory	2023-01-01	2025-04-30	In Progress
26	Inventory cost	3	2	Inventory turnover analysis	Inventory	2023-01-01	2025-05-31	In Progress
27	Inventory security	6	4	Inventory audits	Inventory	2023-01-01	2025-06-30	In Progress
28	Logistics reliability	9	7	Logistics performance review	Logistics	2023-01-01	2025-07-31	In Progress
29	Logistics cost	3	2	Logistics cost analysis	Logistics	2023-01-01	2025-08-31	In Progress
30	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2025-09-30	In Progress
31	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2025-10-31	In Progress
32	Production quality	6	4	Production quality audit	Production	2023-01-01	2025-11-30	In Progress
33	Production cost	3	2	Production cost audit	Production	2023-01-01	2026-01-31	In Progress
34	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2026-02-28	In Progress
35	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2026-03-31	In Progress
36	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2026-04-30	In Progress
37	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2026-05-31	In Progress
38	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2026-06-30	In Progress
39	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2026-07-31	In Progress
40	Logistics reliability	9	7	Logistics reliability audit	Logistics	2023-01-01	2026-08-31	In Progress
41	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2026-09-30	In Progress
42	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2026-10-31	In Progress
43	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2026-11-30	In Progress
44	Production quality	6	4	Production quality audit	Production	2023-01-01	2027-01-31	In Progress
45	Production cost	3	2	Production cost audit	Production	2023-01-01	2027-02-28	In Progress
46	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2027-03-31	In Progress
47	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2027-04-30	In Progress
48	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2027-05-31	In Progress
49	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2027-06-30	In Progress
50	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2027-07-31	In Progress
51	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2027-08-31	In Progress
52	Logistics reliability	9	7	Logistics reliability audit	Logistics	2023-01-01	2027-09-30	In Progress
53	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2027-10-31	In Progress
54	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2027-11-30	In Progress
55	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2028-01-31	In Progress
56	Production quality	6	4	Production quality audit	Production	2023-01-01	2028-02-28	In Progress
57	Production cost	3	2	Production cost audit	Production	2023-01-01	2028-03-31	In Progress
58	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2028-04-30	In Progress
59	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2028-05-31	In Progress
60	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2028-06-30	In Progress
61	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2028-07-31	In Progress
62	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2028-08-31	In Progress
63	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2028-09-30	In Progress
64	Logistics reliability	9	7	Logistics reliability audit	Logistics	2023-01-01	2028-10-31	In Progress
65	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2028-11-30	In Progress
66	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2029-01-31	In Progress
67	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2029-02-28	In Progress
68	Production quality	6	4	Production quality audit	Production	2023-01-01	2029-03-31	In Progress
69	Production cost	3	2	Production cost audit	Production	2023-01-01	2029-04-30	In Progress
70	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2029-05-31	In Progress
71	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2029-06-30	In Progress
72	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2029-07-31	In Progress
73	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2029-08-31	In Progress
74	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2029-09-30	In Progress
75	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2029-10-31	In Progress
76	Logistics reliability	9	7	Logistics reliability audit	Logistics	2023-01-01	2029-11-30	In Progress
77	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2030-01-31	In Progress
78	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2030-02-28	In Progress
79	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2030-03-31	In Progress
80	Production quality	6	4	Production quality audit	Production	2023-01-01	2030-04-30	In Progress
81	Production cost	3	2	Production cost audit	Production	2023-01-01	2030-05-31	In Progress
82	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2030-06-30	In Progress
83	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2030-07-31	In Progress
84	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2030-08-31	In Progress
85	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2030-09-30	In Progress
86	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2030-10-31	In Progress
87	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2030-11-30	In Progress
88	Logistics reliability	9	7	Logistics reliability audit	Logistics	2023-01-01	2031-01-31	In Progress
89	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2031-02-28	In Progress
90	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2031-03-31	In Progress
91	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2031-04-30	In Progress
92	Production quality	6	4	Production quality audit	Production	2023-01-01	2031-05-31	In Progress
93	Production cost	3	2	Production cost audit	Production	2023-01-01	2031-06-30	In Progress
94	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2031-07-31	In Progress
95	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2031-08-31	In Progress
96	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2031-09-30	In Progress
97	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2031-10-31	In Progress
98	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2031-11-30	In Progress
99	Inventory security	6	4	Inventory security audit	Inventory	2023-01-01	2032-01-31	In Progress
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102	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2032-04-30	In Progress
103	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2032-05-31	In Progress
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106	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2032-08-31	In Progress
107	Maintenance cost	3	2	Maintenance cost audit	Maintenance	2023-01-01	2032-09-30	In Progress
108	Maintenance safety	6	4	Maintenance safety audit	Maintenance	2023-01-01	2032-10-31	In Progress
109	Inventory management	9	7	Inventory management audit	Inventory	2023-01-01	2032-11-30	In Progress
110	Inventory cost	3	2	Inventory cost audit	Inventory	2023-01-01	2033-01-31	In Progress
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113	Logistics cost	3	2	Logistics cost audit	Logistics	2023-01-01	2033-04-30	In Progress
114	Logistics security	6	4	Logistics security audit	Logistics	2023-01-01	2033-05-31	In Progress
115	Production efficiency	9	7	Production efficiency audit	Production	2023-01-01	2033-06-30	In Progress
116	Production quality	6	4	Production quality audit	Production	2023-01-01	2033-07-31	In Progress
117	Production cost	3	2	Production cost audit	Production	2023-01-01	2033-08-31	In Progress
118	Maintenance reliability	9	7	Maintenance reliability audit	Maintenance	2023-01-01	2033-09-30	In Progress

Where Next....

- **Understanding risk from global industrial systems perspective**
- **Linking strategic, operational and technical risks to financial implications**
- **Blending qualitative & quantitative approaches**
- **Developing & tailoring tools for key risk categories**
- **Current focus on supply chain risk management and resilience**



Thank you