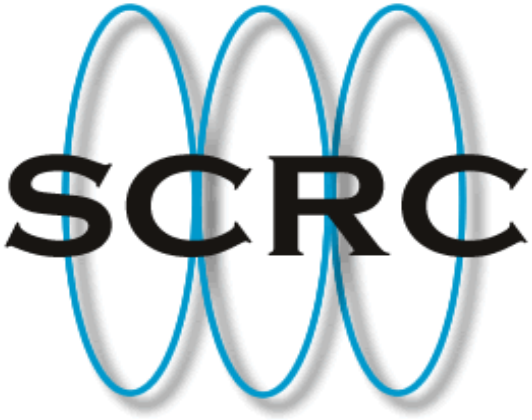

Supply Chain Resource Consortium
College of Management, NC State University
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"An Industry-University Partnership for Supply Chain Research and Education"

Disruptions and Global Sourcing: Building Resilient Supply Chains

Robert Handfield
Bank of America University Distinguished Professor of Supply Chain Management
Director, Supply Chain Resource Consortium
Email: robert_handfield@ncsu.edu

Agenda

- Project Introduction
  - Scope
  - Relevance
  - Components
  - Methodology
- Insights
  - Disruptions
  - Discovery
  - Recovery
  - Redesign
  - Key Enablers
- Organizational Redesign
  - Strategic Sourcing
  - Supply Base Management
  - Operational Issues
  - Enterprise Risk Planning
- Who We Are Working With
- Final Thoughts

Key Research Question

The key question that this research has focused on, is how can companies that are moving towards this global sourcing model, and that are exposed to increasing levels of supply chain risk, design their supply chains to assure uninterrupted material availability and yet operate in a lean/just-in-time manner?

Project Scope

- Disruption definition:
  - Any unplanned delay or stoppage of planned product flow within the supply chain.
- Scope:
  - Supply chain disruptions that impact material availability.
  - Supply chain disruptions originating from international sources.

Relevance to Industry

- Importance:
  - Disruptions to global product flow can be costly and result in significant supply chain delays.
    - Mitroff and Alpaslan (2003) present research on preparing for terrorism and state that **only between 5% and 25% percent of Fortune 500** companies are prepared to handle crises or disruptions.
    - Rice and Caniato (2003) present the results from a company survey in their research that estimates a **$50 million to $100 million cost impact for each day its supply network was disrupted**.
    - Hendricks and Singhal (2003) analyze the stock market reaction when firms publicly announce they are experiencing supply chain glitches or disruptions that cause production or shipping delays. Results of the study of 519 supply chain problem announcements indicate that such announcements **decrease shareholder value by 10.28%.**
    - Knight and Pretty (1996) found that the **impact of a disruption on shareholder was a sharp decrease of almost 8% and a recovery time (if recovery is possible) of 50 trading days**.

Multi-Industry Interview Participants

Industry	Identification	Brief Company Profile
Pharmaceutical	PHARMA1	PHARMA1 is a global pharmaceutical with over 90 sites worldwide in over 30 countries and employs over 100,000 employees. They manufacture prescription medication, vaccines and consumer health products
Multiple: Logistics Provider	LOGPRO1	LOGPRO1 is a logistics solutions provider that offers warehousing and distribution, freight forwarding, supply chain management and IT solutions. They have over 300 warehouse and office location and employ over 10,000 employees.
Military	MIL1	MIL1 designs IT and engineering solutions for national defense, intelligence and other government mission. They employ over 7,000 employees in over 100 offices worldwide. (2003 revenues over $1 billion). The key respondent here also served (20 years) in the military and his/her responses are primarily from this perspective.
Retail	RETAIL1	RETAIL1 is a large retailer (mass merchandise) with more than 1200 stores in the United States. (Sales in 2003 exceeded $45 Billion)
Retail	RETAIL2	RETAIL2 is a discount retailer with over 25,000 employees in over 2000 store across the United States.
Multiple: Logistics Provider	LOGPRO2	LOGPRO2 is a door to door logistics provider, delivery to over 200 countries world wide.
Retail	RETAIL3	RETAIL3 is one of the world's largest retailers stocking over 50,000 items in over 1500 stores in the United States. (Sales in 2002 over $58 billion)
Energy	NUCPOWER1	NUCPOWER1 is a Fortune 250 energy company with more than 24,000 megawatts of generation capacity and $9 billion in annual revenues. They serve over 2.8 million customers.

- Interviewees consisted of executives with job titles including: Chief Operating Officer, Chief Logistics Officer, Vice President of International Supply Chain and Senior Manager of Import Operations.
- With the exception of the person at the nuclear power company, the common theme among their responsibilities was they managed product flow originating from overseas sources.
- It should be noted that the nuclear power company was not dealing with a mass of global product flow, but we selected the company for inclusion in the study as it is one where managing risk and disruptions is critical.

Focus Group Information

- Semi-Annual Supply Chain Resource Consortium Meeting
  - The Supply Chain Resource Consortium (SCRC) at North Carolina State University, April 29-30, 2004

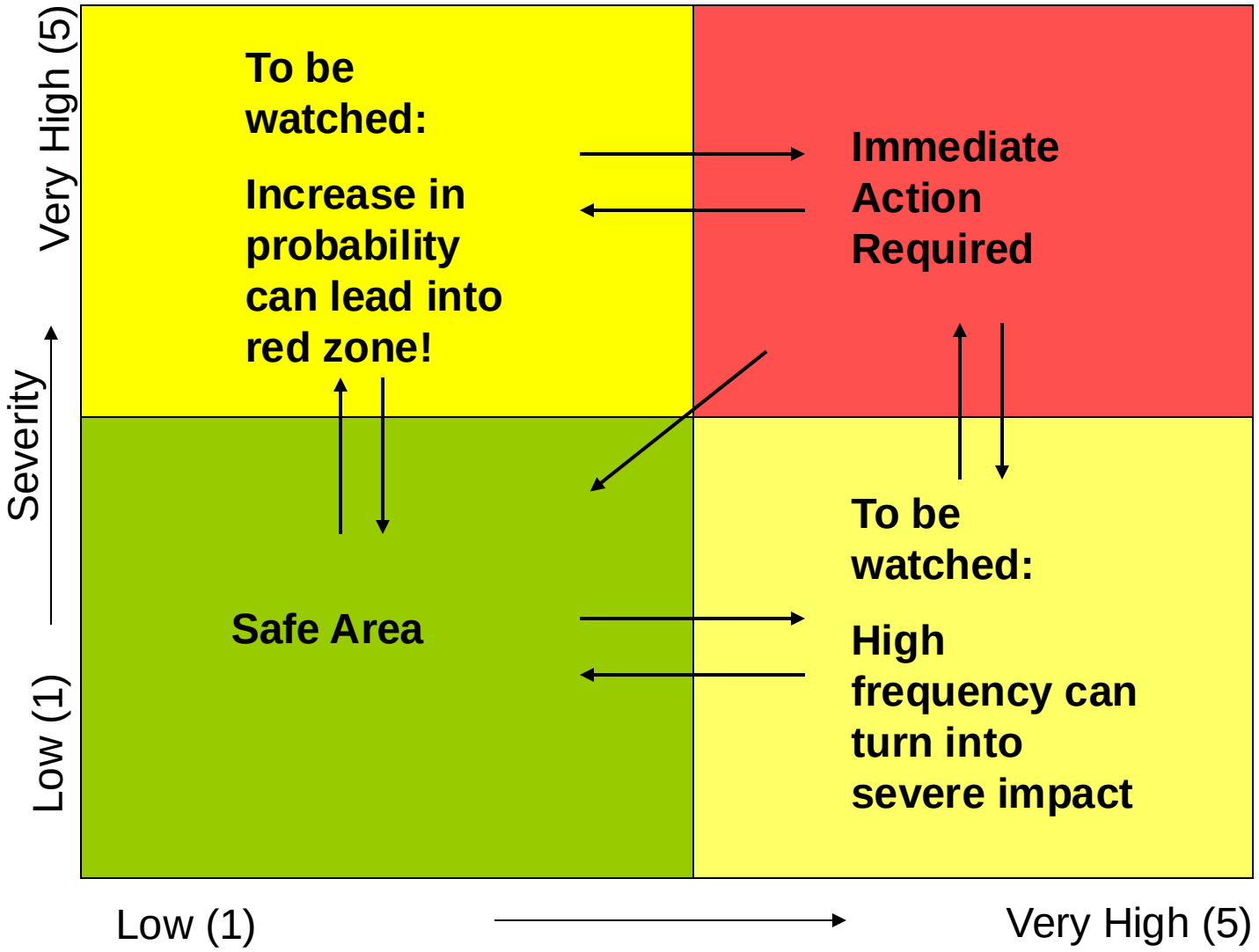
- Facilitation of 3 focus groups utilizing the critical incident technique

- Members of each group described a supply chain disruption and their company's response to it (i.e., a critical incident).

- Each focus group consisted of 10-14 supply chain executives and collectively many industries were represented including airlines, automotive, chemical, construction, energy, fuel, government, heavy equipment, logistics provider, pharmaceutical, plastics, technology and textiles.

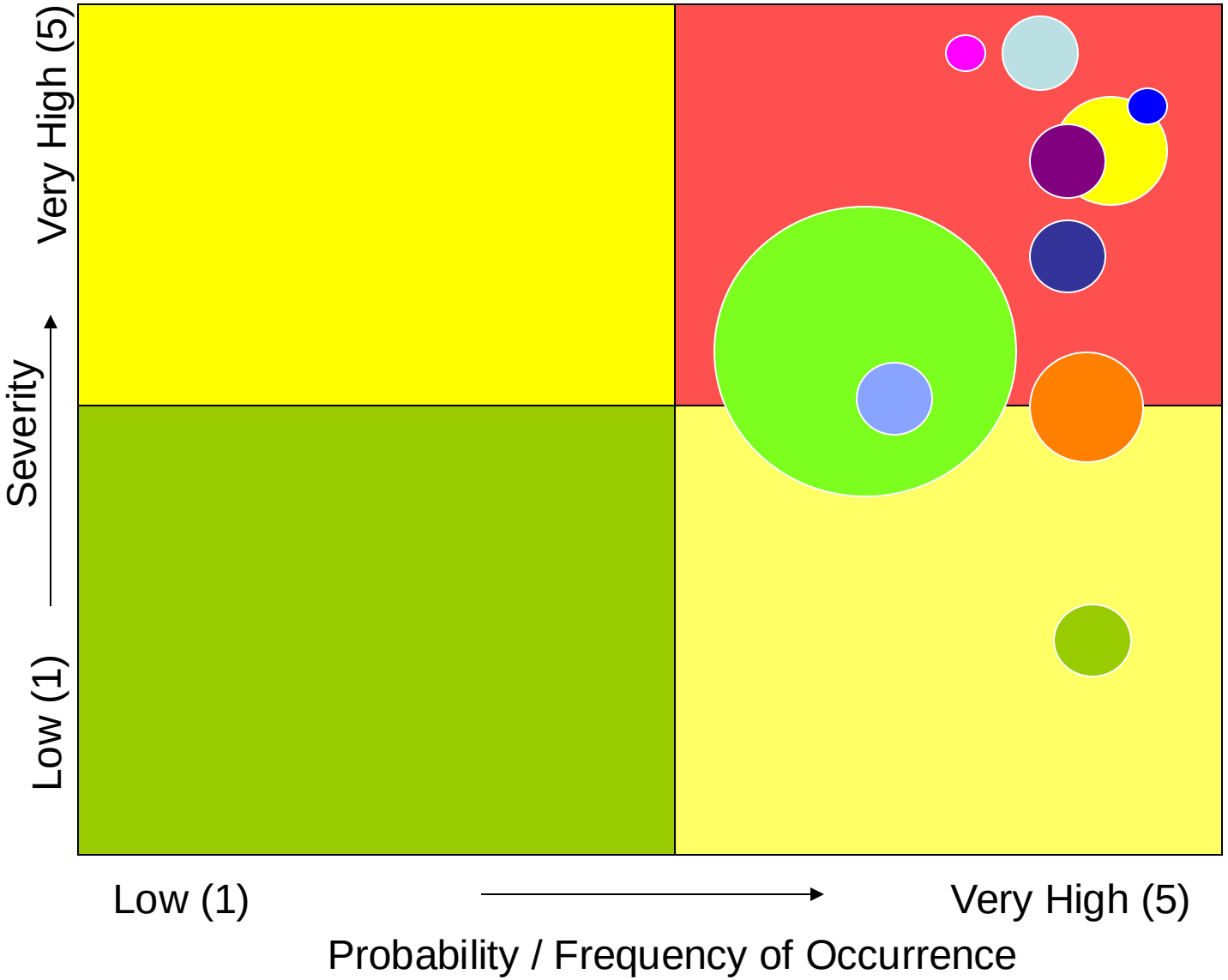
Framework for Understanding Pain Points

Pain Map



Results of our Recent Executive Survey

Based on Expert Opinion



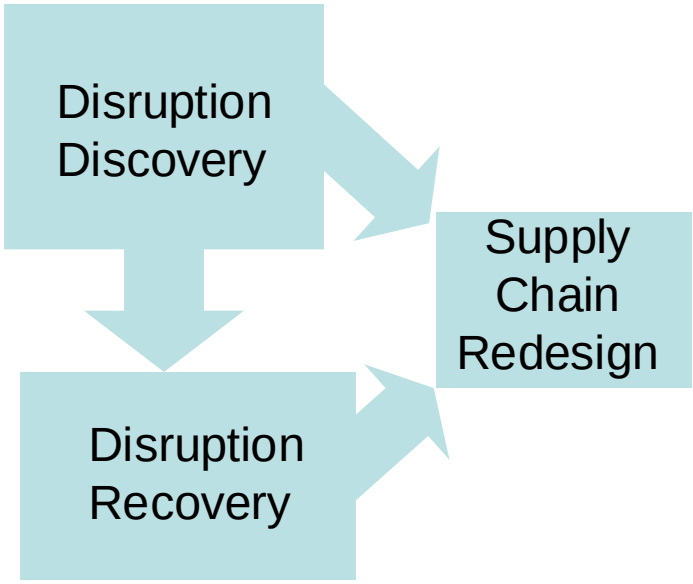
- SC Fragmentation (31%)
- Lack of Global Project Resources (12%)
- Collaboration & BI (10%)
- Commodity Price Increase (10%)
- Global Competition (10%)
- Power Shift (8%)
- Developing SCM Talent (7%)
- Regulatory Compliance (7%)
- IT Integration (5%)
- IP (2%)

Risk Management Framework

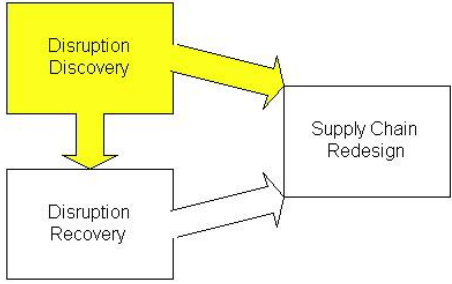
Three key elements of supply chain disruption management.

1) Disruption Discovery:
   What type of detection / intelligence does a firm need to detect disruptions?
2) Disruption Recovery:
   Once the disruption is discovered, how does a firm effectively recover from a disruption?
3) Supply Chain Redesign:
   How can a company strategically re-design its supply chain over time to become more resilient and avoid or easily mitigate future disruptions?

Supply Chain Triad



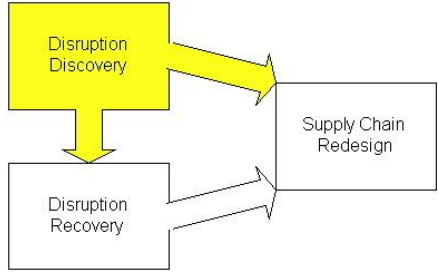
Insights: Disruptions

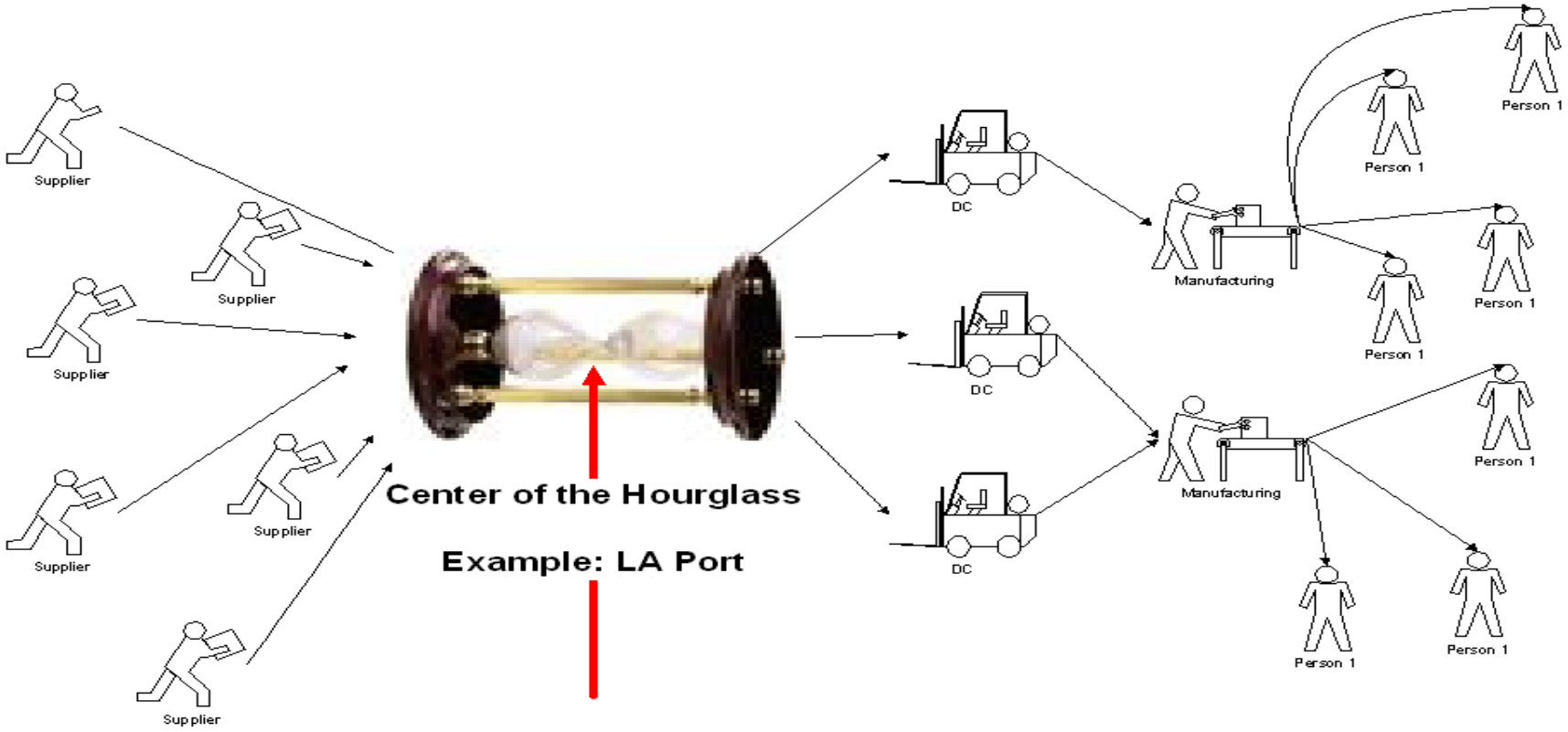


General Characteristics of Severe Failures:

1. Consequences of the disruption captures the public eye
2. Disruption catches company by surprise – no foresight
3. Disruption cause related to a single source/single location
4. Disruption affects availability of a hard to re-source part
5. Be on the look out for choke points or bottlenecks:
   - "Center of the hourglass"

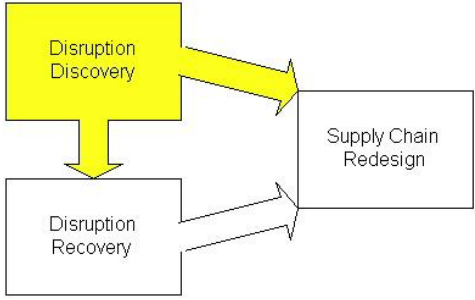
“Center of the Hourglass”





Key Point: These choke points in the supply chain control the **timing** (speed) and **volume** of material flow.

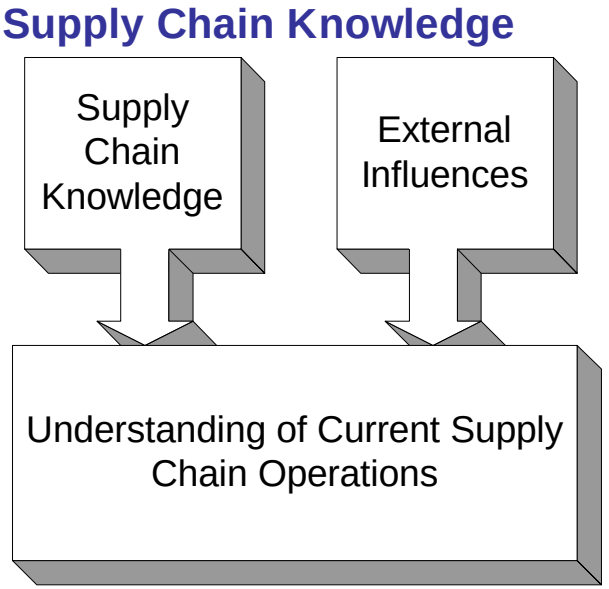
Insights: Discovery



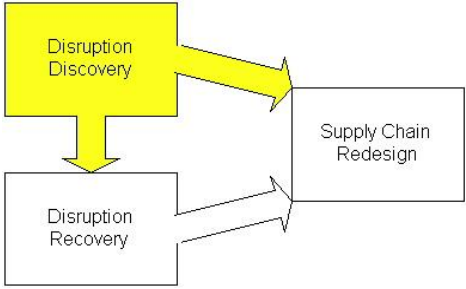
- Supply chain knowledge:
  - Products flows, lead times, inventories, locations, channels
  - Ownership
- External Influences
  - Political, weather, labors issues, etc.
  - Example: Weekly updates by region on political issues, carrier issues, vendors, port issues

These factors lead to a understanding of the current supply chain… so how do you manage disruptions with this model?

Supply Chain Risk Management Framework **Building Blocks:**



Insights: Discovery



Visibility, Visibility, Visibility!!!

- "Visibility is the battleground"
- Both horizontally and vertically
- Visibility of product flows, locations, lead times
- Emerging Tools: RFID
- Understanding the cost of visibility vs. benefits
- Dynamic Supplier Risk Index

Leads to a management by exception with complex, large, global supply chains. "Millions of discrete events in a supply chain in a given year – only way to manage this is by exception."

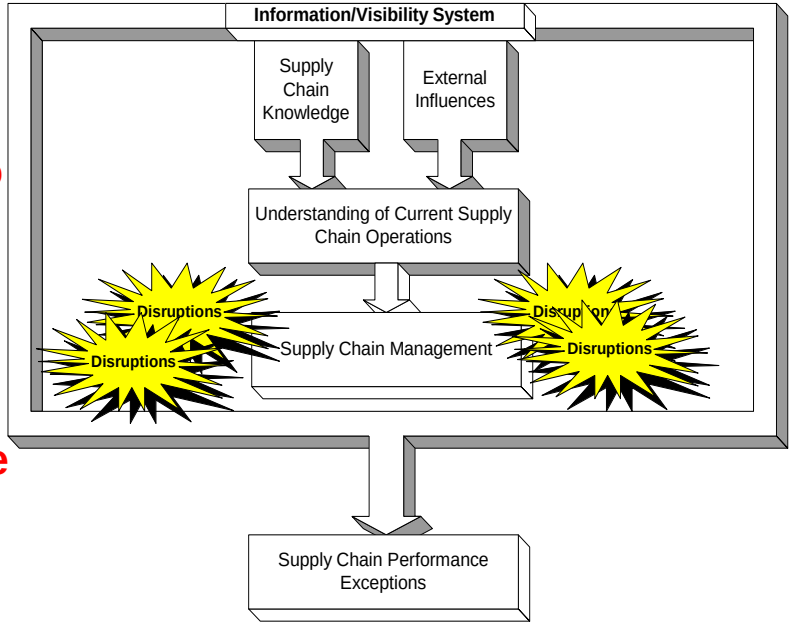
The challenge is to build the understanding of the supply change.

Retail Example: Benchmarked all product flows in the supply chain. Flags raised when outside of control limits.

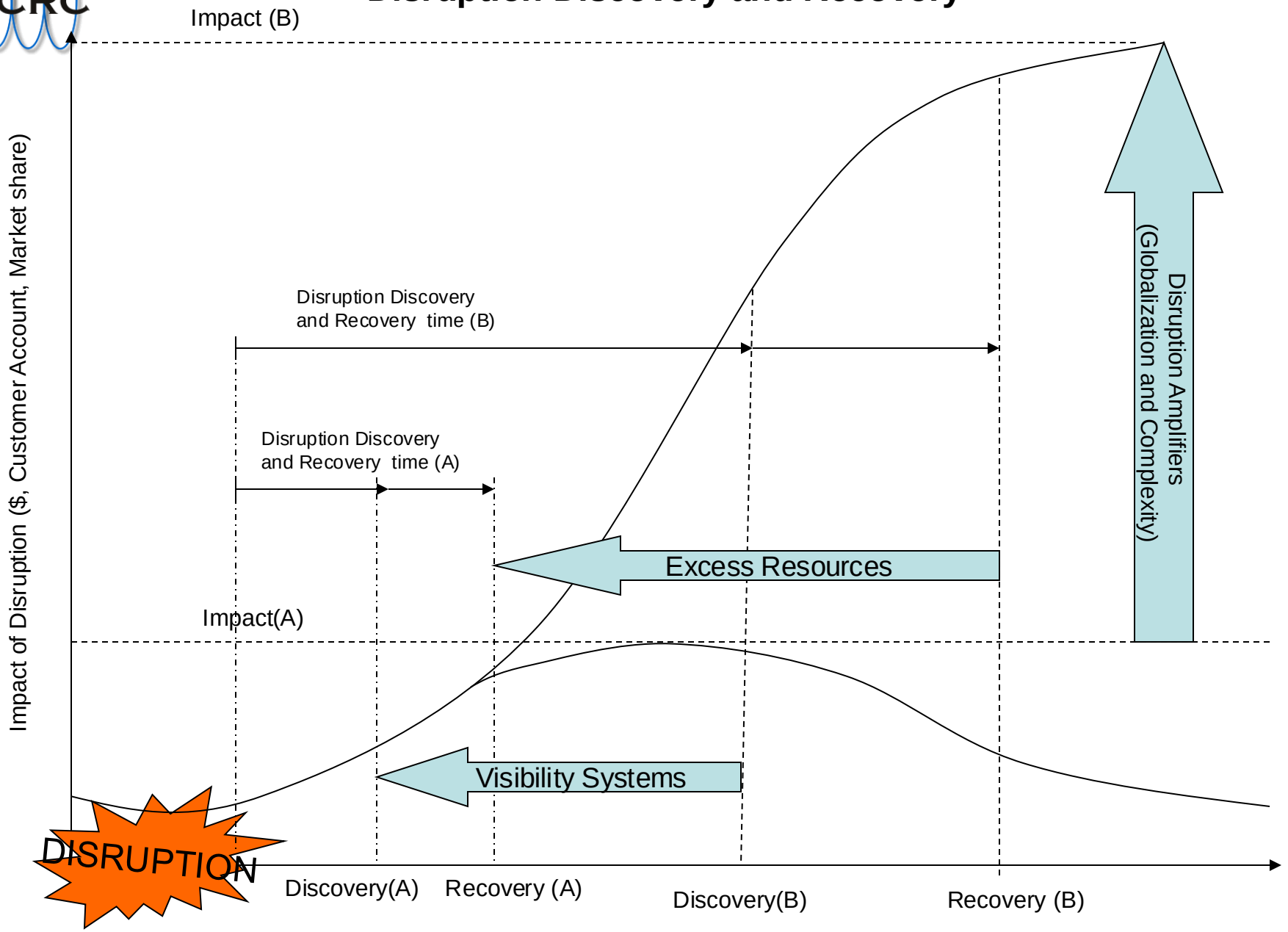
Trucks: 3-4 hours
Shipping Vessels: 1-2 days
Trains: 12 hours

Supply Chain Risk Management Framework **Building Blocks:**

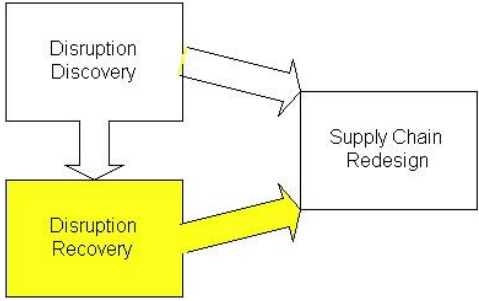
Development of a Visibility System



Disruption Discovery and Recovery



Insights: Recovery

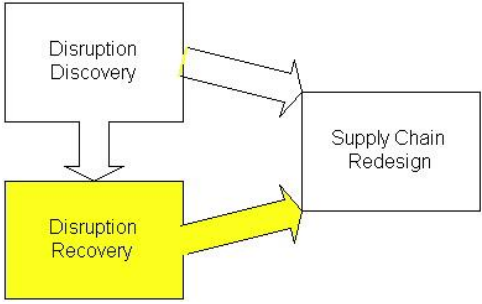


Two forms of Recovery:

1. Proactive:
   - Buffers (Stored protective capacity)
   - Visibility of the supply chain
   - Ownership and understanding of the supply chain
   - Predictive Analysis:
     - Intelligent Search Agents
     - Dynamic Risk Index
     - Recognitions of symptoms of a pending disruption
     - Alternative plans in place
   - "Hot Plans": Preplanned actions with several options
     - Military:
       - "Training never ends"
       - Robust supply channels
     - Requirement of every phase in the supply chain
       - Note the need to understand potential risks and their severity
   - Damage Control -- Reachability Analysis

2. Reactive:
   - Overtime
   - Premium freight
   - Expediting

Insights: Recovery



Enablers of Effective Disruption Recovery:

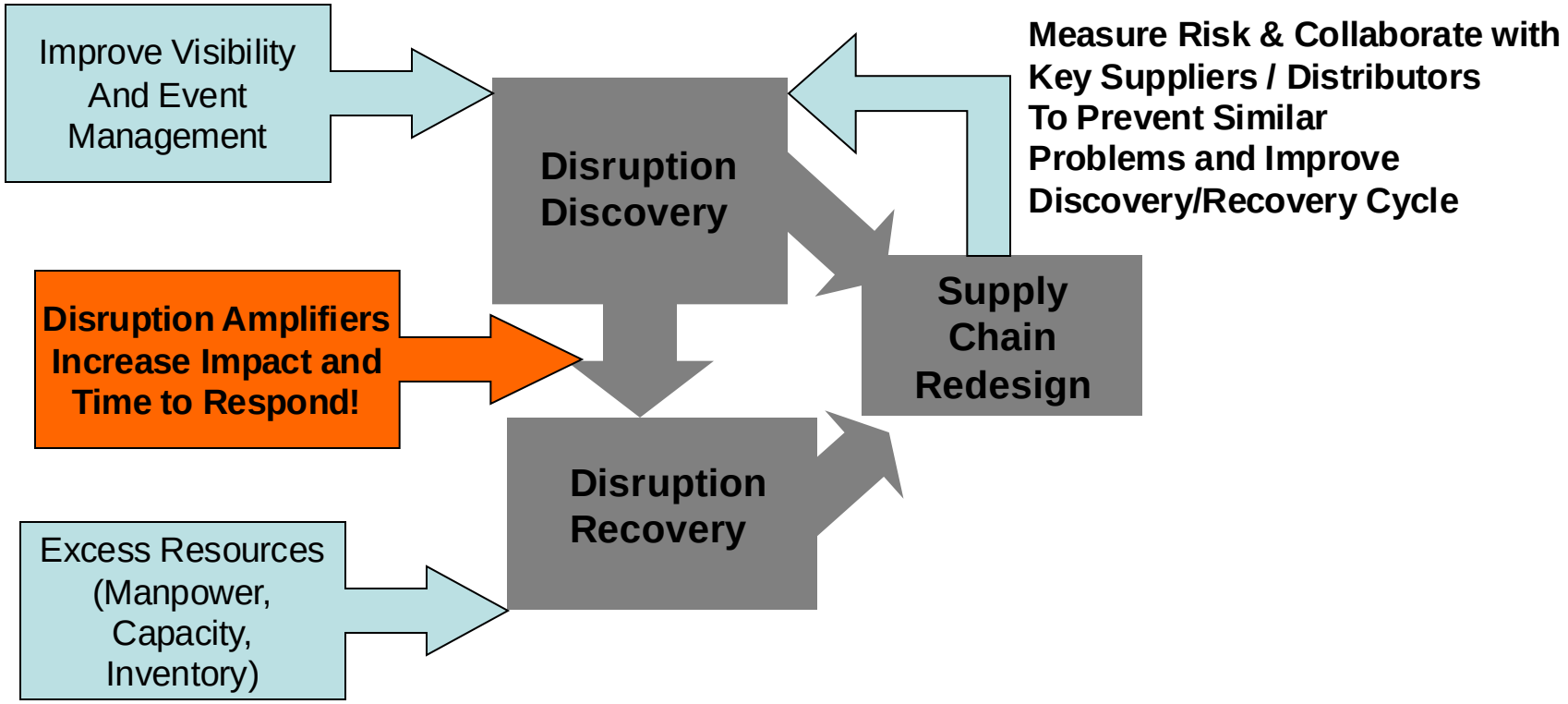
Now that you have flagged the disruptions, it comes down to *people*.

- Experienced
- Educated
- Empowered
- Armed with a plan
- Armed with a process

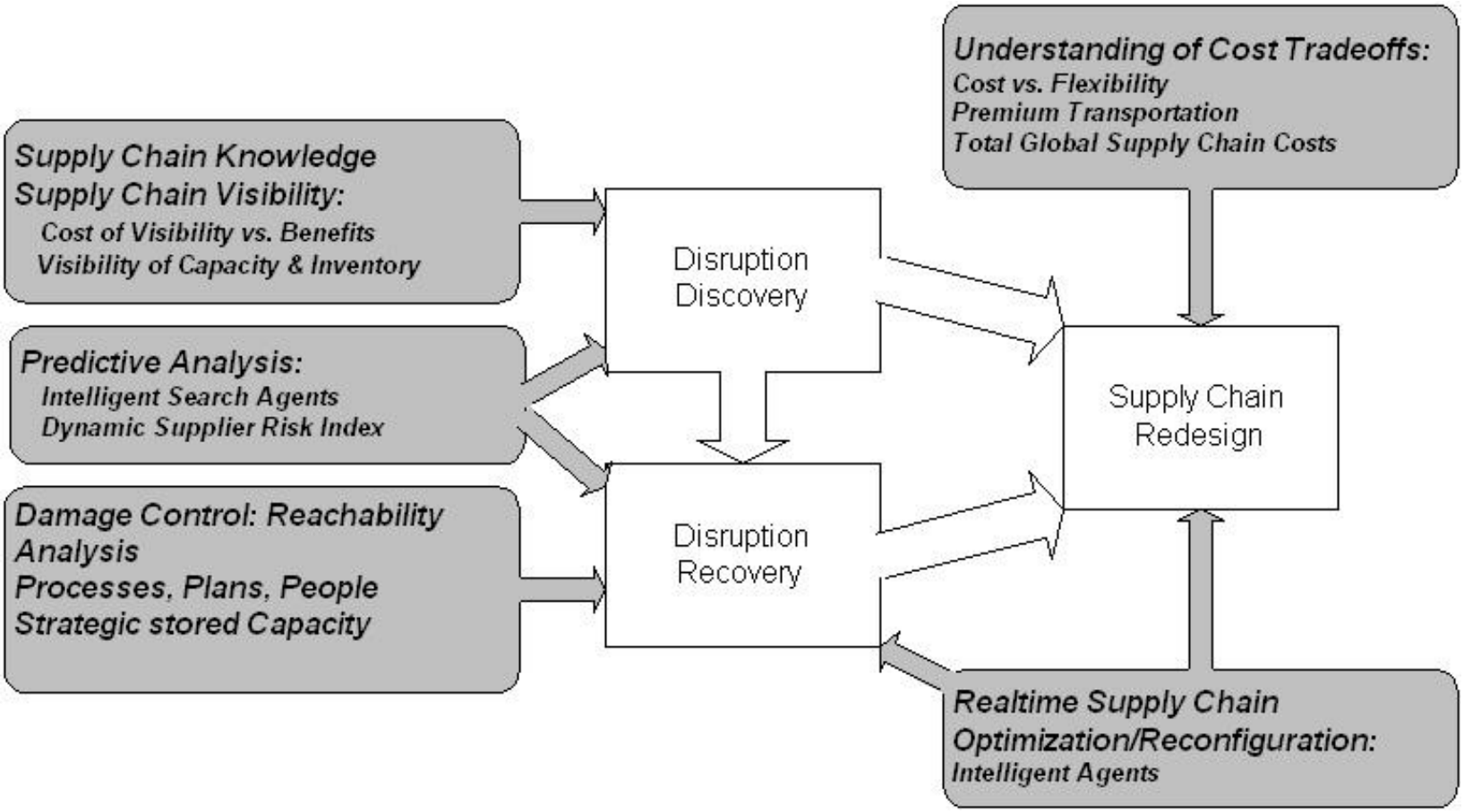
Key Point: Systems and Processes must be managed by <u>PEOPLE</u>.

Does your organization have this?

Risk Management Approach



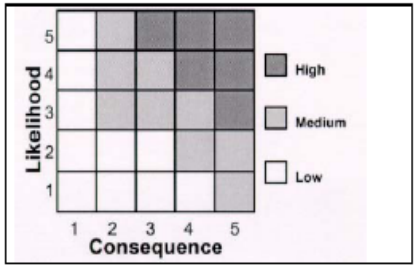
Quantitative Tools Must Be Aligned With Business Processes



Contingency Planning Template

Contingency Planning Template

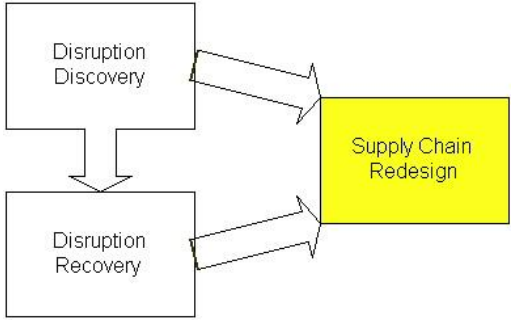
Project/Crew:



L= Likelihood = 1 through 5 from table description
C= Consequences= 1 through 5, highest of technical, cost and schedule- see table description.
R= Overall Risk = L x C = **L**ow, **M**edium, **H**igh from pictograph

WO#	Description/Risk	L	C	R	Mitigation Strategy/Contingency Actions
186062 (**EXAMPLE**)	Inspect SW-175. Never been pulled. Could require belzona repair	2	4	M	Belzona repair would be initiated. Tasks and sequences are in schedule. Unlikely that degradation beyond belzona repair would occur.

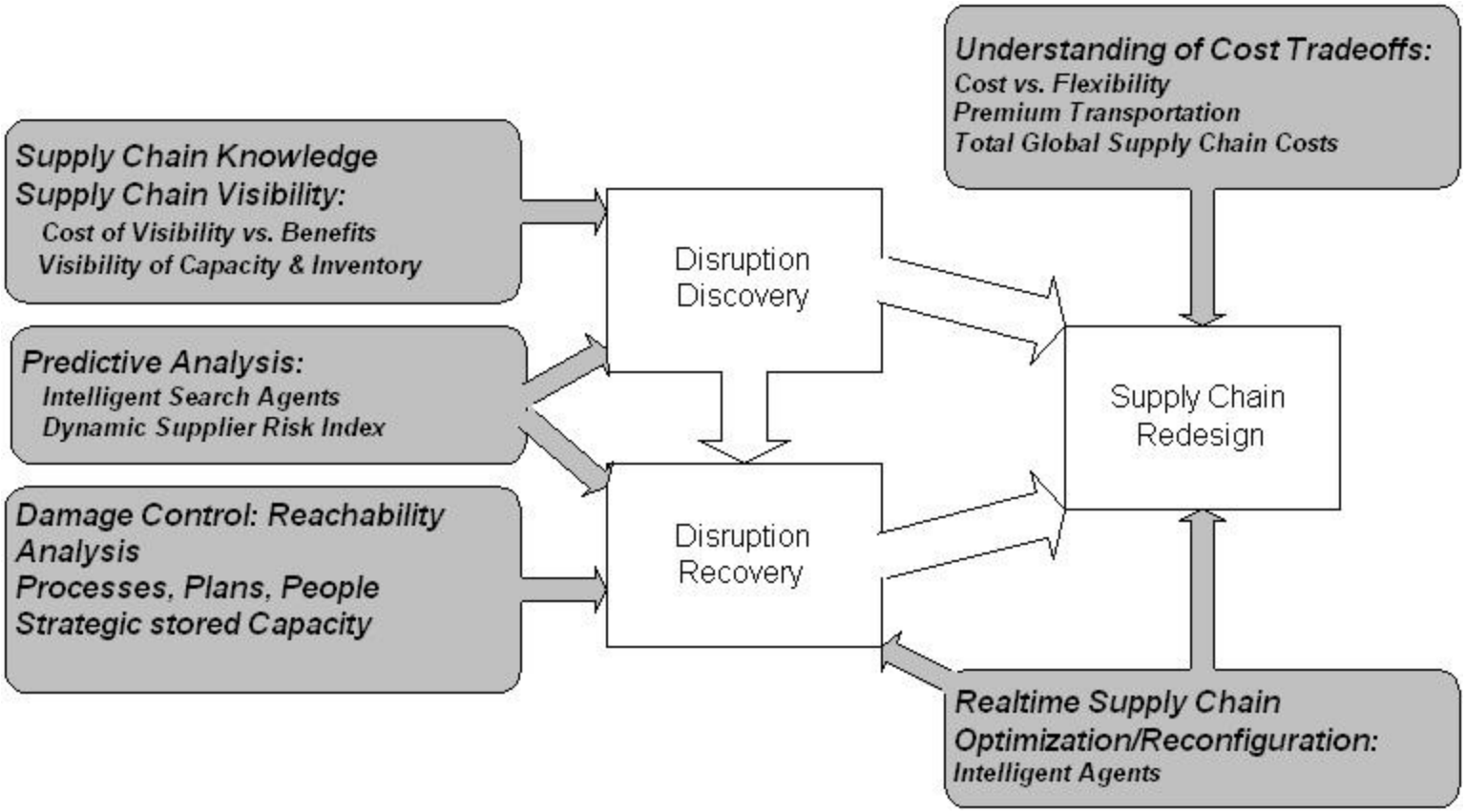
Insights: Redesign



General Characteristics Needed:

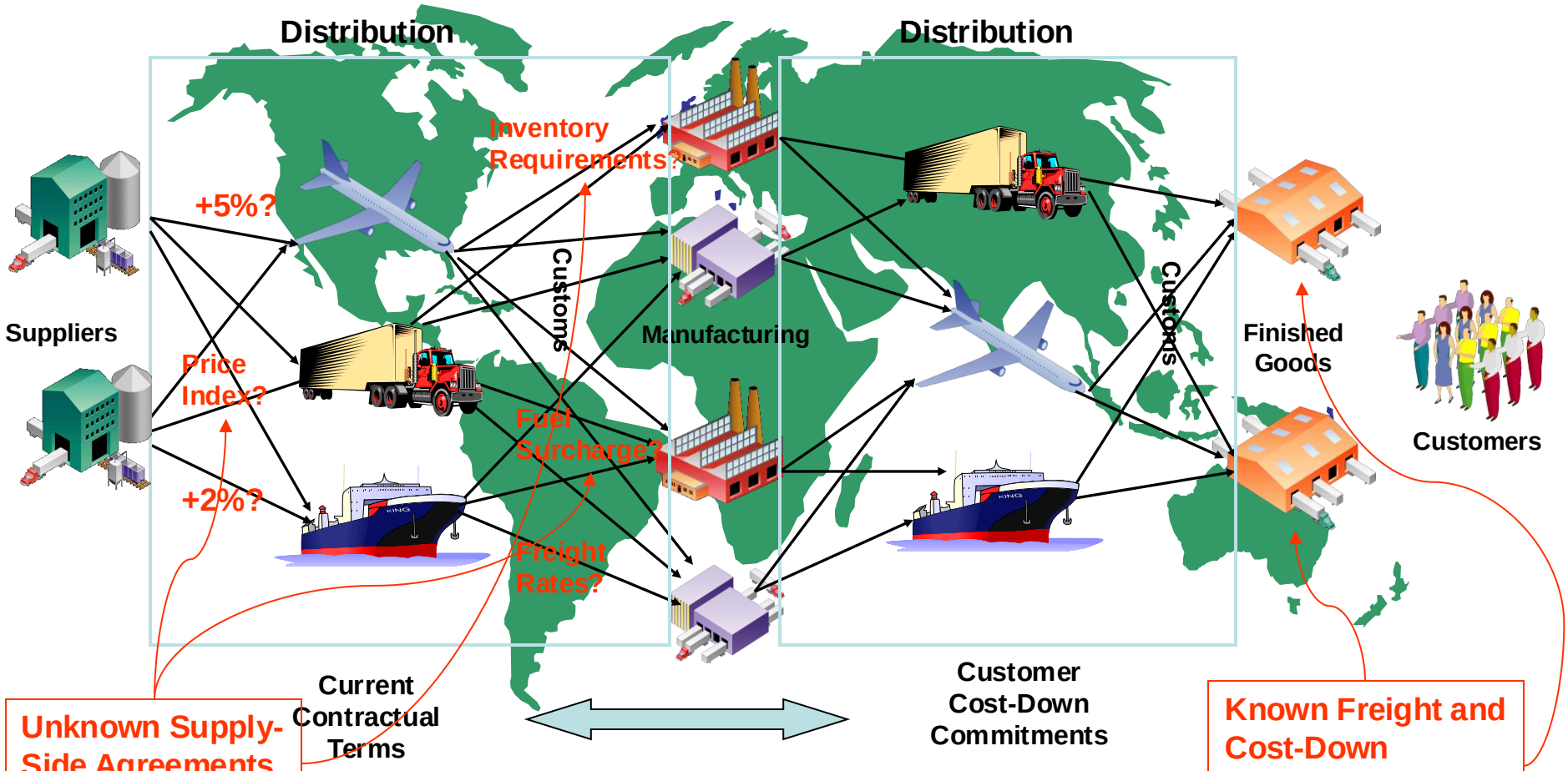
- Flexibility
  - Tradeoffs: No free lunch in terms of flexibility
- Strategically placed excess capacity
- Visibility
  - Visibility, defined as knowing how much inventory is available and where it is located in the chain, is likely the most important aspect of a successful system for dealing with disruptions.
- Common Goals

Key Enablers of the Supply Chain Triad



Who Are We Working With?

The Pressure on the Capabilities and Delivered Value of Soucing and Logistics within this Company is Tremendous

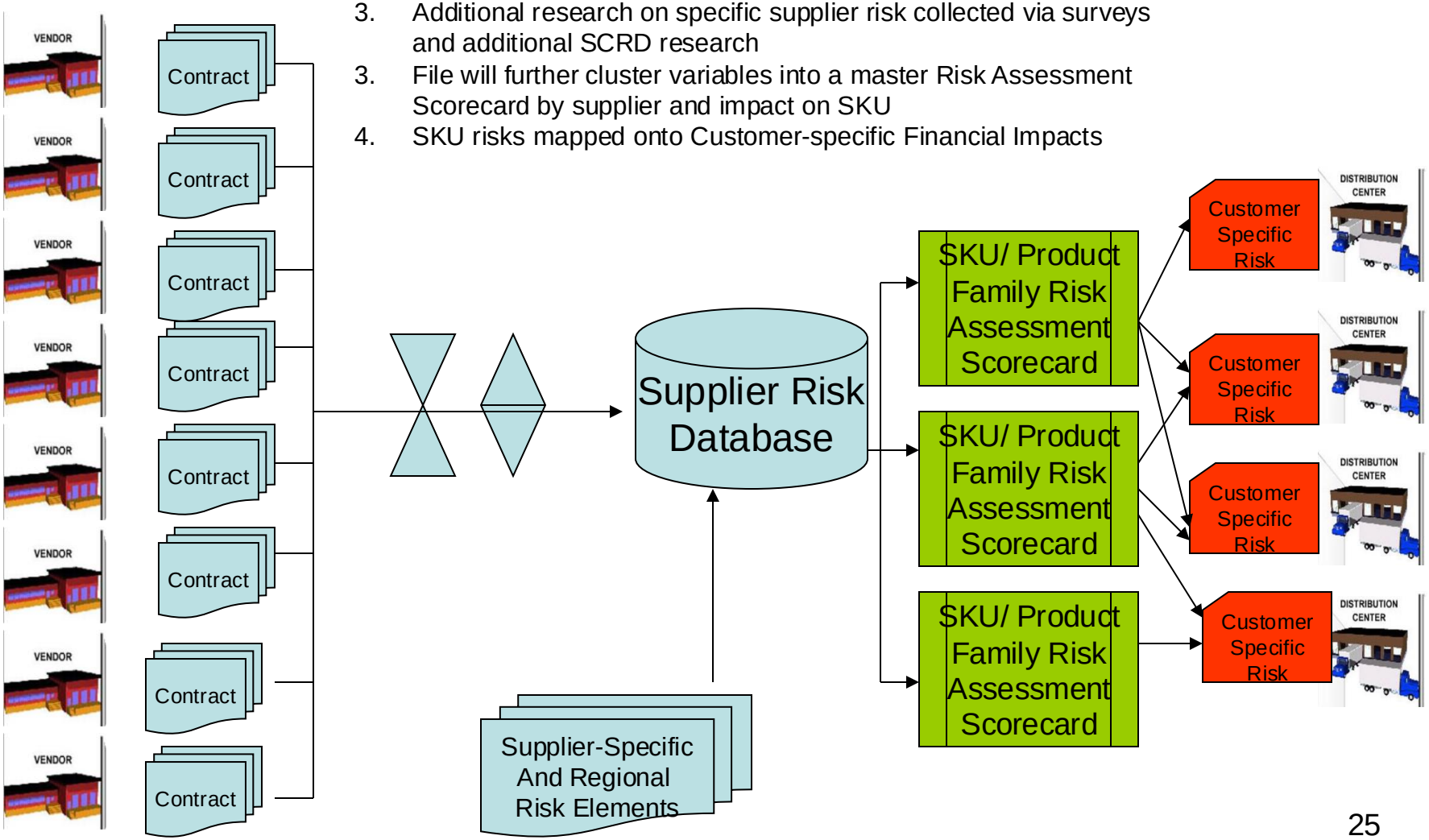


Alignment of Supplier Contractual Terms to Fulfill Customer Commitments Is Unknown!

Phase I Approach

1. All contracts will be collated and sorted into a master file
2. Data will be screened using Sifttext software to define critical variables defining level of financial exposure
3. Additional research on specific supplier risk collected via surveys and additional SCRD research
3. File will further cluster variables into a master Risk Assessment Scorecard by supplier and impact on SKU
4. SKU risks mapped onto Customer-specific Financial Impacts

Customers



SKU Specific Risk Scorecard and Financial Exposure

			Probability of Event	X	Consequence Cost of Disruption	= Impact

Risk Score	Metric	Threshold Level	Probability Risk	Impact Criteria (Worst case)	Cost of Impa	Net Exposure
Supplier: Yokohama SKU: Pine Fragrance						
Financial Quick Ratio	0.8	1.2	20%	Missed Customer Delivery	$1M	200,000
Current Capacity Utilization	85%	90%	40%	Shutdown plant	$1M	400,000
Single Source Alternatives	Single Source Does not renew contract	10%	30%	Stop product launch	$5M	1,500,000
Country Risk Japan	1 = Stable	4 = Unstable	<1%	$500,000	0	0
Price Agreements	5% price increas	-5%	80%	Agree to price increase	$100,000	
				Total Exposure		$2,100,000

Customer-Facing Impact

Customer	**Walmart**	**Commitments**	**95% Ontime**
Product Family	**Axius**		**5% Cost down in 2006**
SKU	**PineCar Scent**		**Inventory turns = 6**
		Contract Size:	**$5,000,000**

Supplier Inputs into BOM		% of Supplier's Shipments Committed to this Product	Customer Exposure	Supplier Total Exposure	High Risk?	Mitigation
Yokohama	Fragrance	50%	$2,500,000	$2,100,000	Yes	Alternate source or re-negotiate contract
Ryoko	Cardboard	20%	$1,000,000	$100,000	No	
Xinmin	Packaging	10%	$500,000	$10,000	No	

Risk Management Framework

Global Sourcing Leadership Team (Governance)

Key Risk Indicators (Drivers)

Supply Risk	Supplier Performance	Technology Trends	Macro-Econ. Trends	Public Policy
• Obsolescence • Bankruptcy • Competitive Threats • Quality Audits	✓Delivery Performance ✓Quality Performance • Risk Ratings	• Material changes • Process changes	• Commodity prices • Currency • Government stability	• Medical device liabilities • Quality requirements

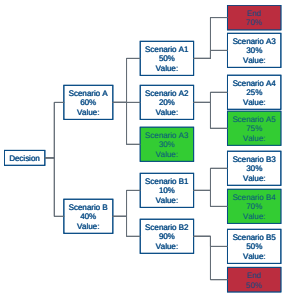
Risk Mitigation Strategies (Capabilities)

Known Risks

Impact[1]	Low	High
High	Mitigate with Supplier	Re-Source / Re-Design
Low	Supplier Quality Assurance	Monitor Performance

Frequency of Occurence[2]

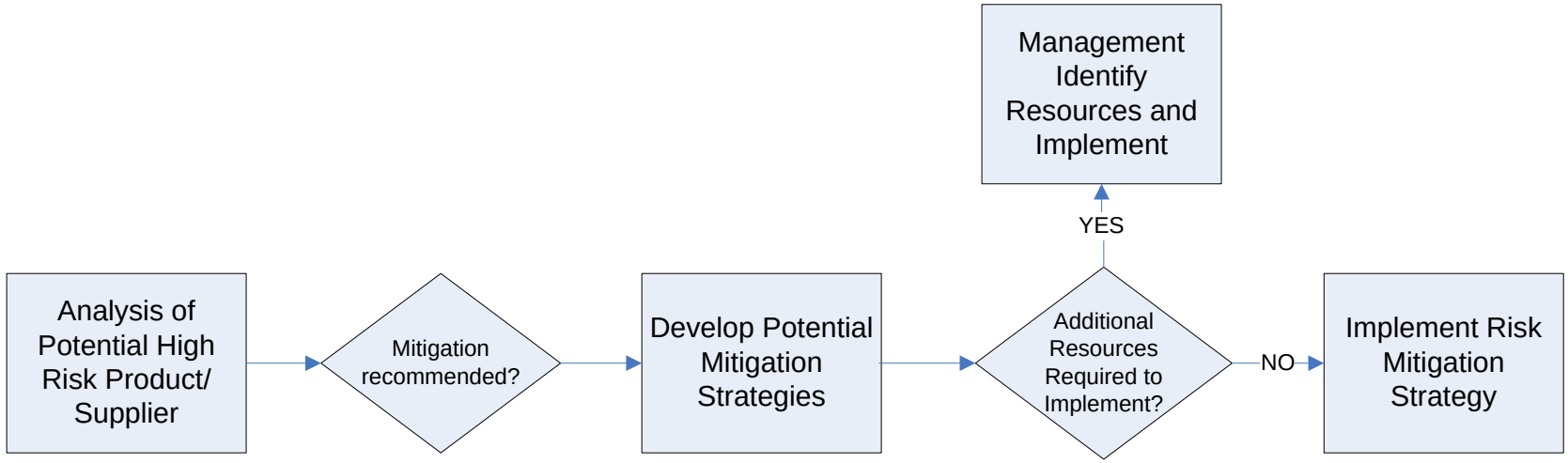
Contingency Planning/Risk Decisions



War Games / Real Options

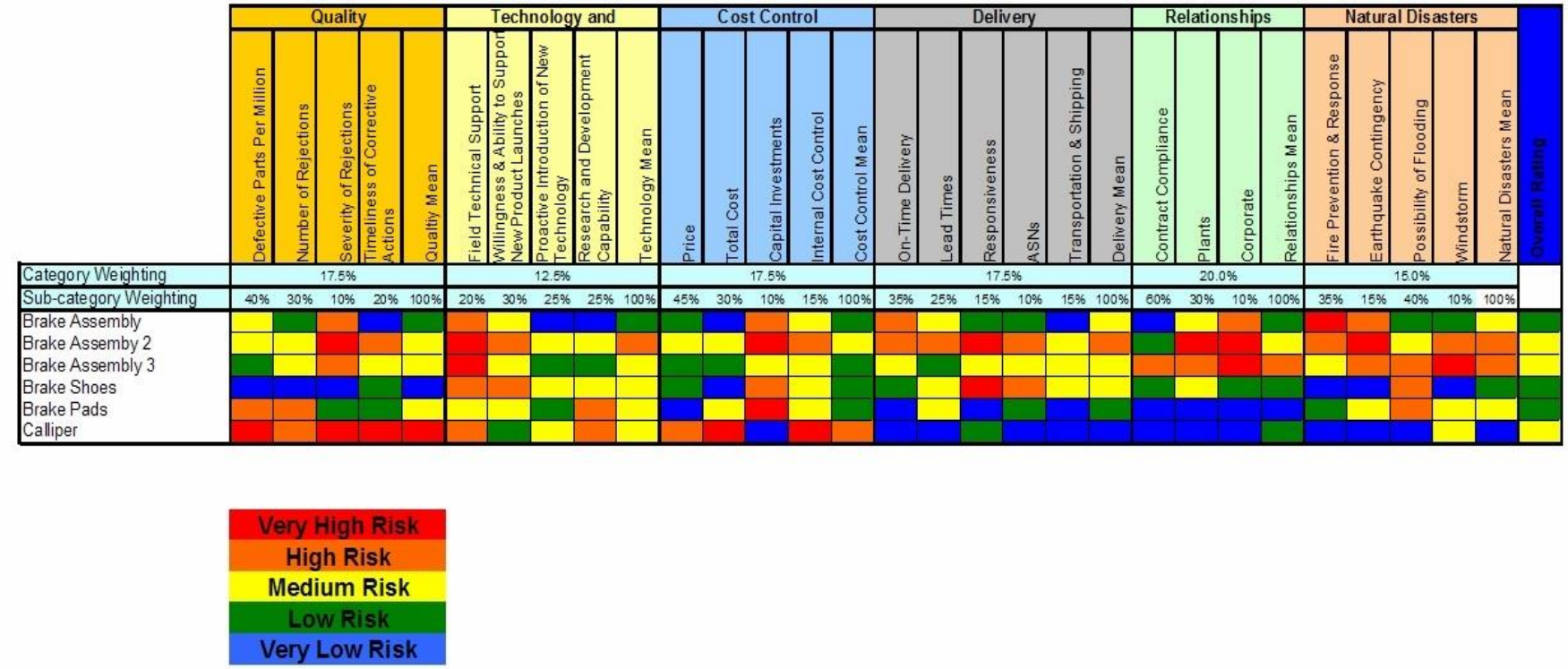
[1]Revenue implications
[2]As measured by Key Risk Indicators

Developing Risk Mitigation Strategies



Who?	Supply Chain Analyst	Supply Chain Analyst	Supply Chain Analyst, MEs, Procurement, Quality as needed	Supply Chain Analyst
What?	• Basic information from procurement, mfg. engr., quality • Key risk drivers		• Improved coordination • Increased inventory • New source • Product redesign	• Coordinate/perform activities as needed

Supply Risk Scorecard



Very High Risk
High Risk
Medium Risk
Low Risk
Very Low Risk

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New Alerts

US Customs plans new CoO ……
(Read More)

Alerts Archive

Merck sets up warehouse at Taipei
(Jan 31st, 2005)

Danzas and DHL merge
(Jan 2nd, 2005)

SE Asia hit by Tsunami
(Dec 26th, 2004)

Flu epidemic in Nigeria;
(Dec 22nd, 2004)

Needs Action

Shanghai seaport has delays of three days *(Read More)*

For Information

Yellow Trucking Net up by 14% *(Read More)*

Crude Oil prices top $60 (Read More)

Key Indicators

Crude Oil Price	$61.05

Risk Values

	Value	Acceptable Max
Steel Component Risk	45	50
Plastic Component Risk	32	35
LED Component Risk	**91**	60
Glass Component Risk	43	45
Transport Component Risk	11	80
Direct Matl' Commodity Risk	**29**	25
Services Commodity Risk	22	60
Global Risk	**32**	35

Key Take Aways: Strategic Sourcing

Strategic sourcing primarily deals with the solicitation for, negotiation with and the contracting of sources of material supply.

- Regular screening of suppliers with respect to potential supply chain risks through self-assessment templates to identify high potential disruptors, and use of such information in the RFQ process
- Requirement of each potential supplier to produce a detailed plan of disruption awareness, and to identify supply chain risk management capabilities which can be executed if disruptions occur in the supplier's own supply base network.
- Requirement to include information on level of visibility of material flows that can be electronically shared with GM.
- Including expected costs of disruptions and operational problem resolution in the total cost of strategic sourcing decision process.

Key Take Aways : Supply Base Management

Supply base management issues deal with the ongoing interaction with existing suppliers as well as the transport of the material from these sources to domestic warehouses and points of use.

- Weekly teleconferences with critical suppliers to identify current issues that may disrupt daily operations, and tactics to reduce them.
- “Exception” Event Planning Systems to discover critical logistics events that exceed normal planning parameters on an exception basis, which can trigger managerial action to mitigate the impact of the disruption. This area includes gathering supply chain intelligence and monitoring of supply base to allow proactive maneuvers against material flow disruptions.
- Security enhancements that comply with new initiatives in Customs-Trade Partnership Against Terrorism, Container Security Initiative, and others.
- Pilot testing of RFID technologies to track containers in distribution channels.
- Detailed disruption incident reporting following a major disruption event, to identify root cause and failure mode and effects analysis to learn from and prevent recurrence of similar events.

Key Take Aways : Operational Issues

Operational issues include all processes from the point of delivery by the supplier and include the bank/buffer of inventory held at warehouses, manufacturing locations, and distribution centers.

- Improve visibility of inventory buffers in domestic distribution channels at a part-level, to assess contingency and scenario planning.
- Classification of buffered material to ensure appropriate inventory positioning to mitigate risk of disruptions.
- Greater training and education to improve decision-making capabilities, and equip managers and associates with plans and processes for managing disruptions when and if they occur.

Key Take Aways : Enterprise Risk Planning

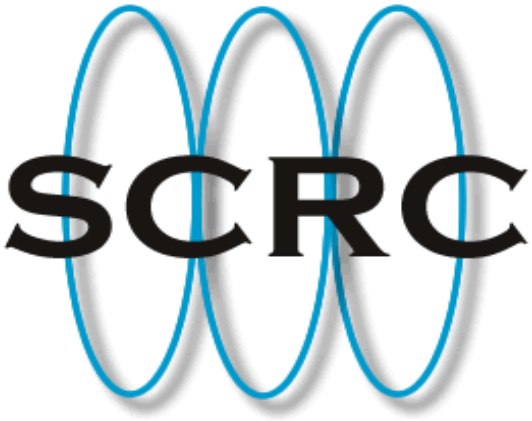
Enterprise risk planning/modeling span system-wide issues pertaining to disruptions, including system-wide supply chain redesign issues.

- Visibility to demand, inventory, and capacity levels at key nodes in the supply chain, including ports and shipping locations. Although no current solutions exist, this should be a major goal for future planning.
- Predictive analysis systems, incorporate intelligent search agents and dynamic risk indexes at major nodes in the supply chain to identify potential problems.
- Real-time supply chain reconfiguration, to enable real-time rescheduling of shipments or contingency plans in response to disruption discovery
- Damage control plans across the supply chain, achieved through modeling of supply chain events and scenario planning.
- Supply chain redesign, to understand cost tradeoffs between key strategies such as increased inventory, premium freight, and flexible processes, enabled through application of dynamic supply chain optimization tools.

Final Thought: Threats

- Global sourcing is increasing
- In global supply chain, chances of the disruption and impact severity increase
  - Length
  - Complexity
  - Congestion

Bottom Line: Dealing with disruptions is a critical issue for the future.



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