Network Science. (Barabasi, 2016)

Strategic Applications of Network Science in Supplier Mgmt.

Why? SM operates in an increasingly complex and dynamic environment where (global) networks dominate. A strategic approach enables companies to understand, describe, design, and optimize their SC as interconnected systems. This goes beyond operational efficiency, to encompass strategic insights, resilience, and innovation.

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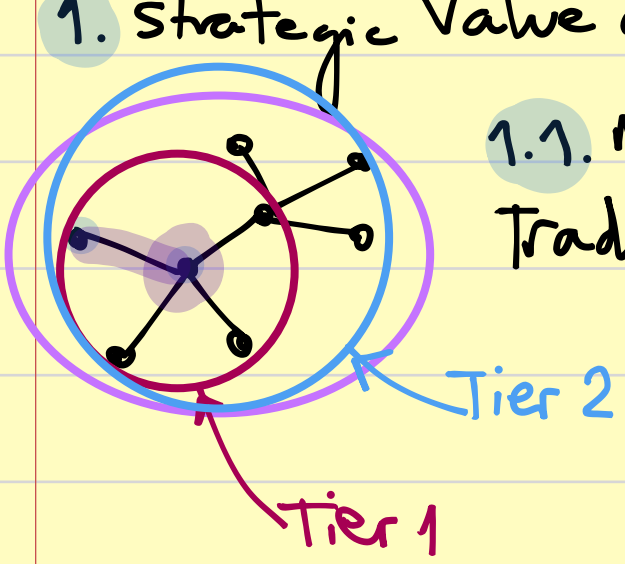
1. Strategic Value of Network Science in SM.



1.1. Move beyond individual suppliers.

Traditional SM emphasizes dyadic (one-to-one) relationships, focusing on improving specific supplier performance. Network science shifts the lens to:

- MULTI-TIER VISIBILITY. Understanding the dependencies and flow of goods across multiple layers.
- INTERDEPENDENCIES. Capturing how disruptions at one node affect the rest of the network.
- SYSTEM-WIDE OPTIMIZATION. Balancing cost, resilience, and performance across the entire network.

1.2. Addressing SC Complexity

Using Network Science strategically:

- REDUCES BLIND SPOTS: Identifies hidden risks in multi-tier SC.
- ENABLE PRO-ACTIVE DECISION-MAKING: Uses predictive models to anticipate disruptions.
- FOSTERS INNOVATION: thighlights collaborative clusters for co-development and cost-sharing.

1.3. Aligning Network Science with Business Objectives.

Some of these key strategic goals:

- COST LEADERSHIP: Reducing inefficiencies through better network design.
- DIFFERENTIATION: Enhancing customer value by ensuring faster delivery or better quality through strategic supplier positioning
- RESILIENCE: Building adaptive SC that can withstand disruptions.

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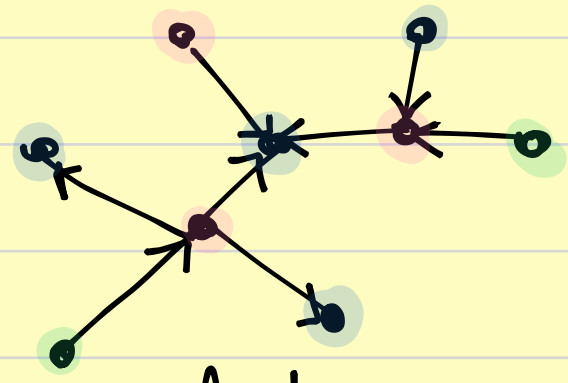
2. Key Network Science Concepts for SM Design.

2.1. Graph Analysis

A graph is a mathematical concept which describes networks. A grap G is a list of NODES (suppliers, manufacturers, distribution centers, and customers), EDGES (flow of goods, capital, or information), and WEIGHTS (strategic factors like volume, cost, or criticality).

$G = \{N, E, W\}$ ≡



key strategic questions include:

- Which nodes and edges are critical for resilience?
- How centralized is the network?
- Are there unnecessary bottlenecks?
- Where can redundancy add the most value?

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2.2. key strategic KPIs to measure SM from a Network Science Perspective:

- CENTRALITY. Provides insights into the strategic role of different nodes in the SC.
  - Betweenness Centrality. Identifies critical suppliers acting as intermediaries. Losing such a node can fragment the supply chain
  - Eigenvector Centrality. Identifies influential suppliers connected to

other critical players. It highlights systemic risks.

- Closeness Centrality. Identifies nodes that can efficiently distribute products, ideal for logistics optimization.

- MODULARITY & CLUSTERING. Clusters represent groups of closely connected supplies or regions.
  - HIGH MODULARITY. Useful for isolating risks in localized disruptions.
  - Low MODULARITY. Promotes flow efficiency but increases global interdependencies.

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3. Applications of Network Science in SM.

3.1. SC resilience through Redundancy.

Network Science can help you identify where redundancy is most needed by evaluating vulnerabilities in the network:

. CRITICAL SINGLE POINT OF FAILURE: suppliers or facilities with high betweeness centrality but no alternatives.

. CLUSTER RISK: geographic clusters or suppliers vulnerable to shared risks (eg. natural disasters, political instability).

STRATEGIC ACTION:

1) Diversify critical nodes and create redundancies.

2) Negotiate contracts with secondary suppliers for on-demand scalability.

3.2. SUPPLIER COLLABORATION & INNOVATION NETWORKS.

Analyzing modularity can highlight clusters where suppliers can collaborate on innovation. (eg. Automotive suppliers working in close networks can co-develop electric vehicle components.)

STRATEGIC ACTIONS.

1) Promote partnerships within high-modularity clusters.

2) Encourage co-investment in technology platforms for shared innovation.

3.3 PREDICTIVE DISRUPTION MANAGEMENT

Using network analytics, companies can simulate disruptions:

. NODE REMOVAL ANALYSIS. Examines the impact of removing critical suppliers.

. Flow RE-DISTRIBUTION. Simulates how goods can be rerouted in real-time.

STRATEGIC ACTIONS:

1) Develop preemptive contingency plans for high risk nodes.

2) Invest in digital twins for real-time simulation.

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4. CHALLENGES & FUTURE DIRECTIONS.

4.1. Challenges.

- DATA AVAILABILITY. Lack of visibility of Tier 2 & Tier 3 suppliers.
- DYNAMIC NETWORKS. SC evolve rapidly, requiring frequent updates.
- COORDINATION COST. Implementing changes across networks can be expensive and time consuming.

4.2. Future directions.

- AI-driven Networks. Machine Learning models can predict disruptions & optimize flows in real-time.
- Blockchain Integration. Enhancing transparency and trust.
- Sustainability Metrics. Embedding environmental and social impact through network science models