Hochschule Worms
University of Applied Sciences

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SGR-Chain: Supply chain risk analysis

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Objectives

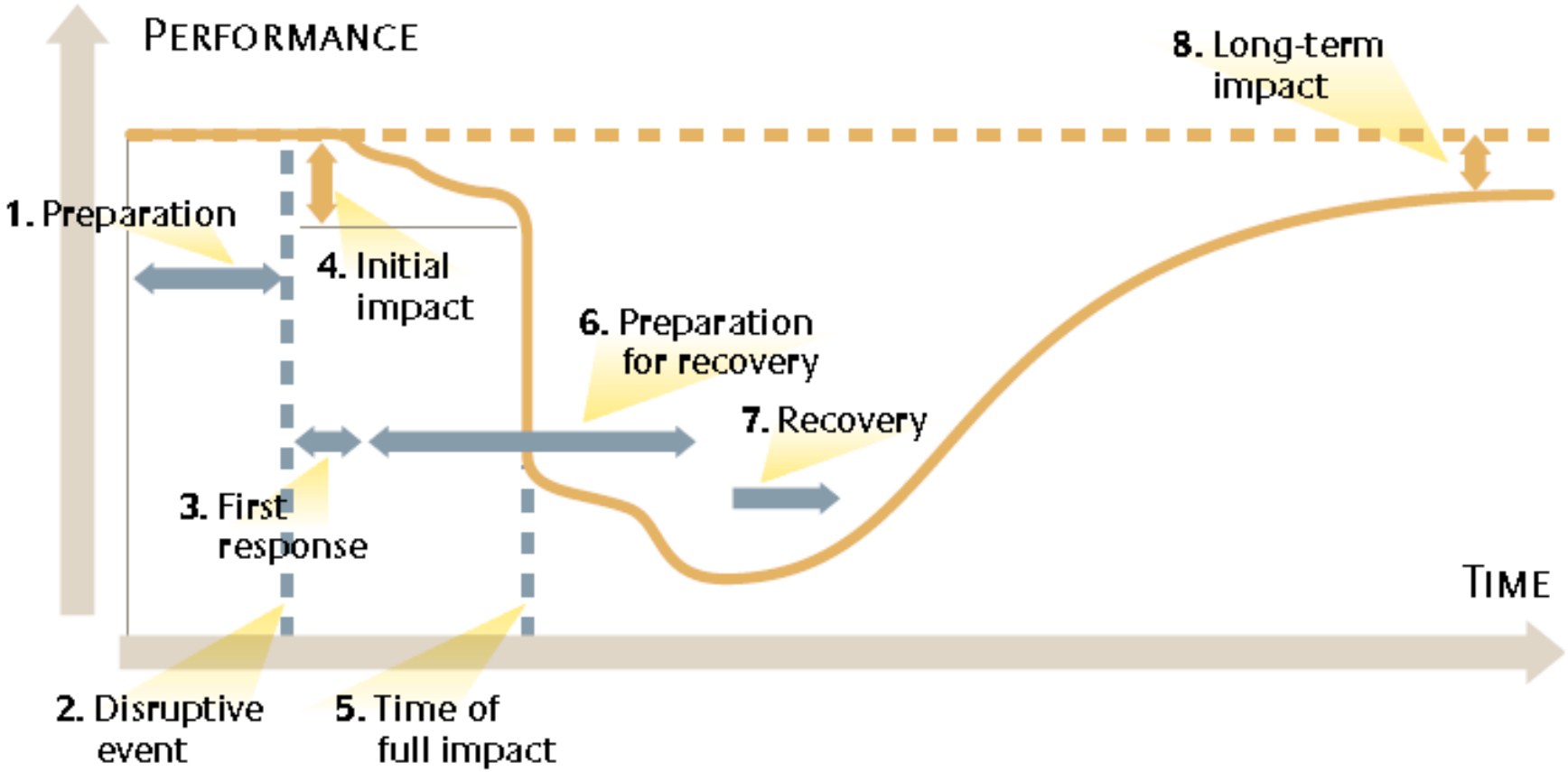
- **What are the key objectives of this module?**

- After this module, you will be able to:
  - Understand the **concept of resilience**
  - Get to know approaches for **identifying** and **evaluating supply chain risks**
  - Conduct a **risk analysis** in a supply chain simulation

Agenda

1	Resilience and risk analysis in supply chains
2	Case study: E2E risk app for the supply chain of a internet service provider

Disruption Profile



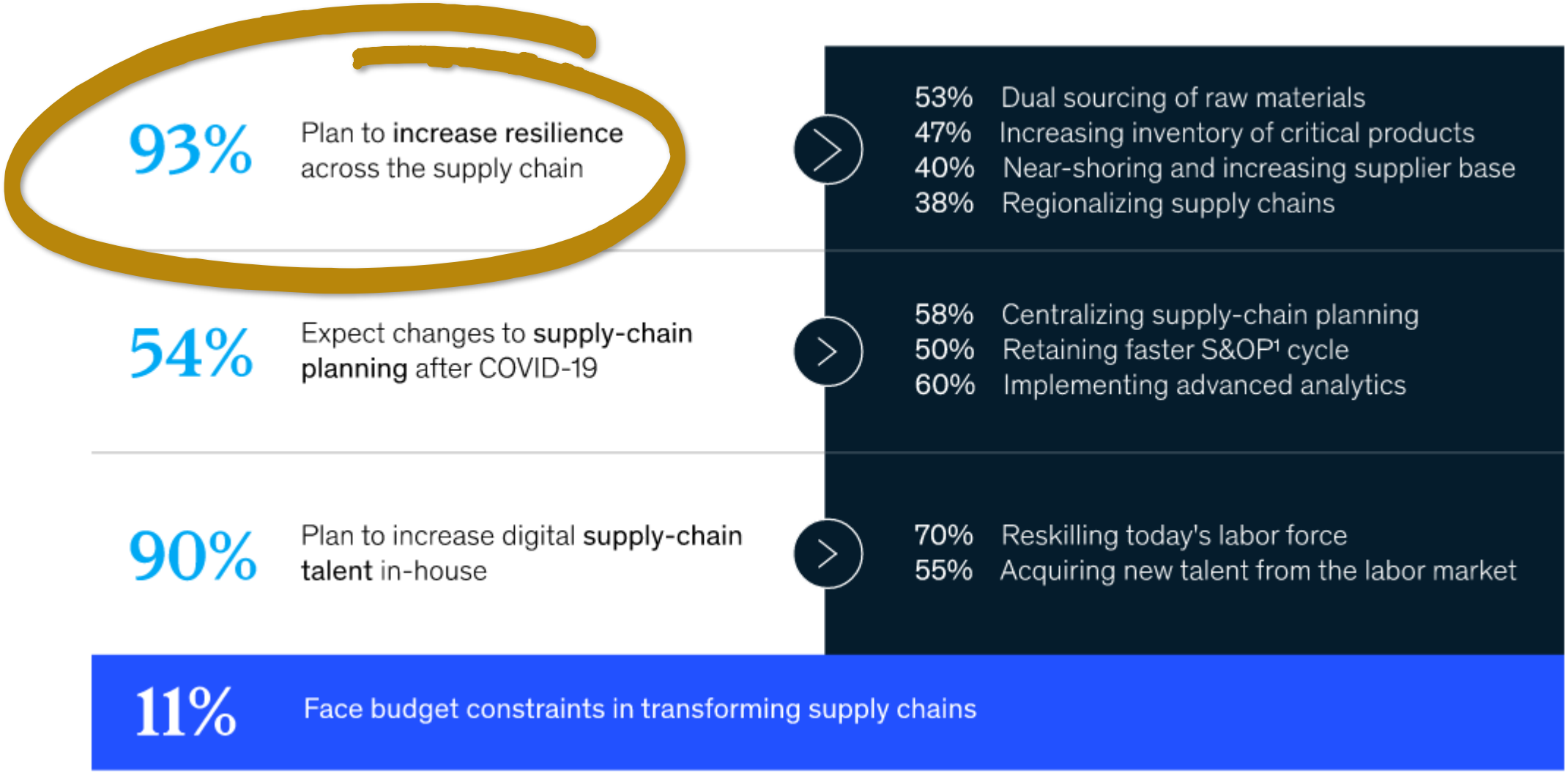
Source: Sheffi and Rice (2005)

Supply Chain Resilience and Robustness

- **Supply chain resilience** is “the ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed”,

- and **supply chain robustness** is “the ability of the supply chain to maintain its function despite internal or external disruptions” (Brandon-Jones, 2014).

The pandemic: A wake-up call for more resilience



Source: www.mckinsey.com/capabilities/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains

Both internal and external risks can disrupt the supply chain

Internal risks

BMW car production disrupted due to supply problems

Shortage of steering systems from Bosch meant thousands of cars could not be built

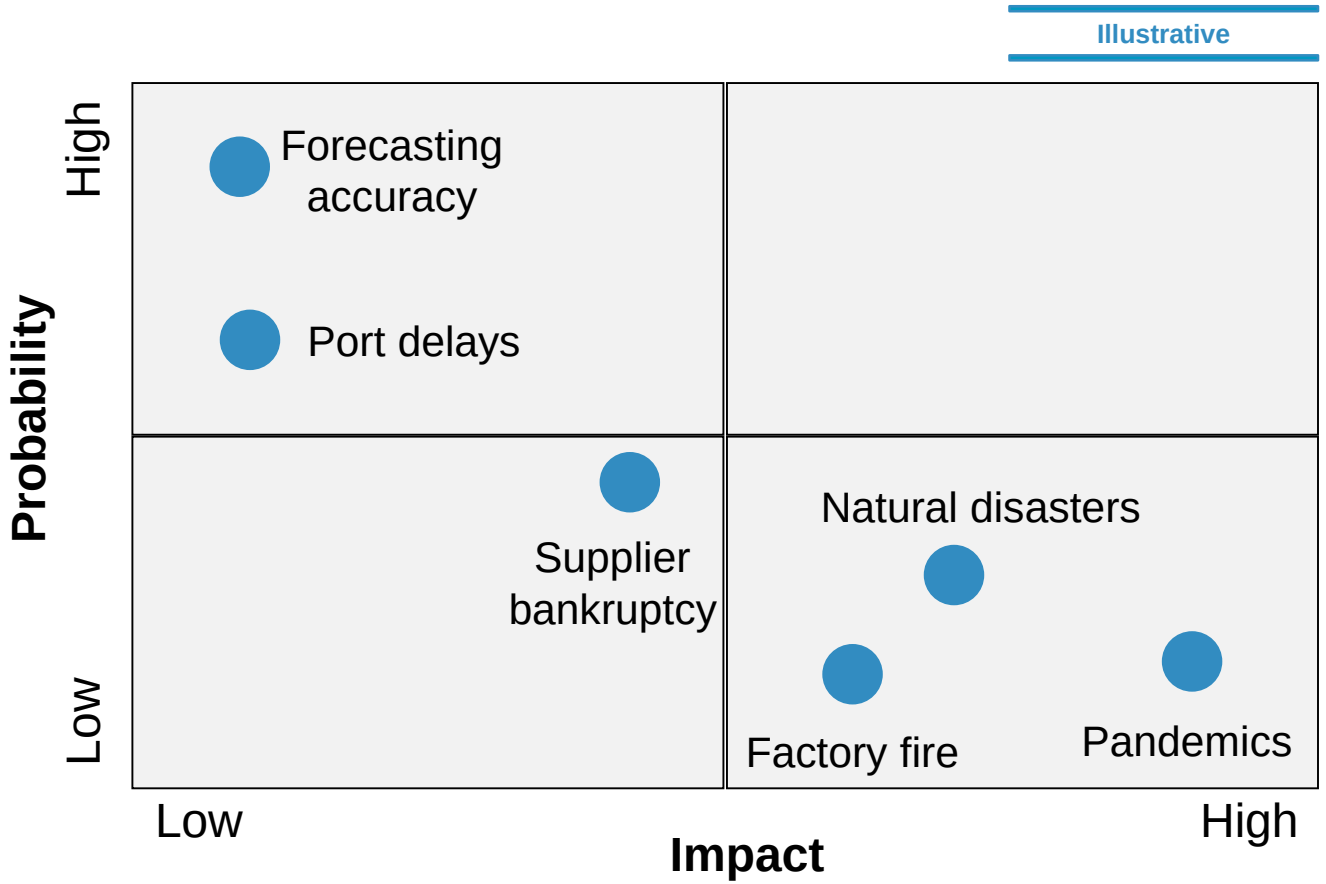
External risks

Drugmakers braced for coronavirus disruption to China supplies

Chief of India's Cipla warns of Chinese lockdown cutting off access to essential ingredients

Source: www.ft.com

The risk-matrix: A commonly used tool for risk analysis in supply chains

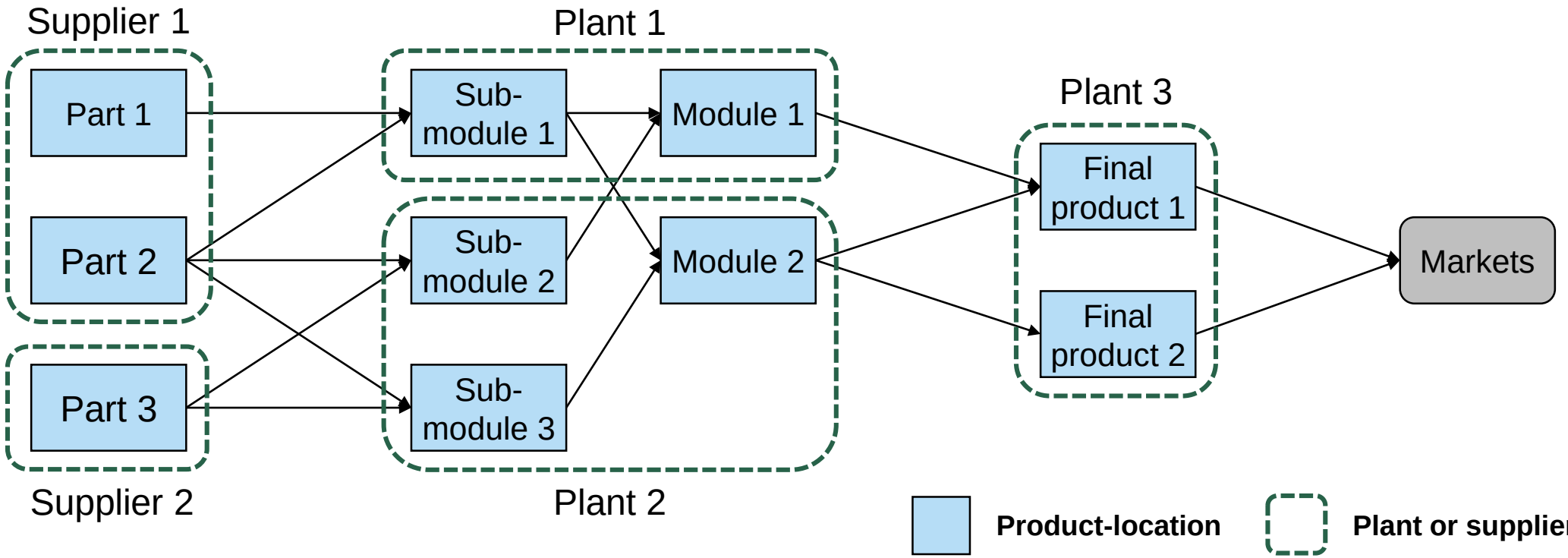


Limitations:

- **Identifying all relevant risks** is often overwhelming for companies
- **Probability trap**: Rare but high-impact events ("black swans") are often overlooked (e.g., the COVID-19 pandemic)
- **Risk exposure**: Companies struggle to quantify the impact of supply chain disruptions

- **The risk matrix** is commonly used to evaluate and prioritize risks based on their potential impact and likelihood of occurrence.

Schematic representation of a supply chain: Plant versus product-locations



- **A product-location** refers to a unique combination of a specific product and its associated location (plant, supplier) within a supply chain.

The risk exposure index and time-to-survive metric of Simchi-Levi et al. (2015)

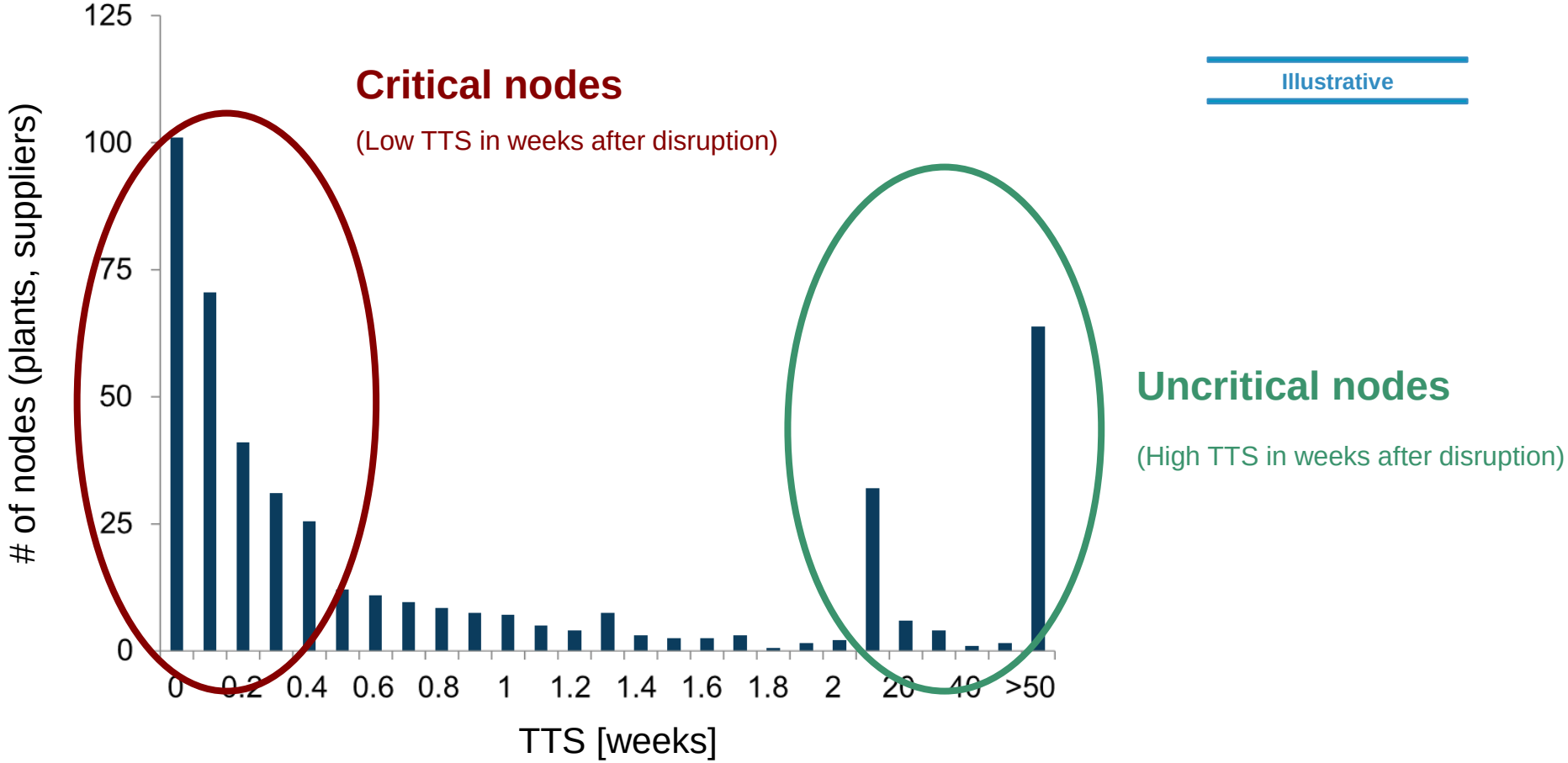
General approach:

- Simchi-Levi et al. propose to shift attention to the impact of potential failures at nodes along the supply chain (such as the breakdown of a supplier), rather than the cause of the disruption.
- The approach uses linear programming to model the supply chain as a mathematical model that can be populated with data (e.g., from ERP systems) commonly available in companies to calculate risk metrics.

Risk metrics:

- **Time-to-recover (TTR):** The time it takes for a particular node in the supply chain (plant or product location) to restore full functionality after a disruption.
- **Time-to-survive (TTS):** The maximum duration that the supply chain can match supply with demand after a disruption of a particular node, i.e., the time until the first shortages occur.

The Time-to-survive metric allows to identify critical nodes in a supply chain

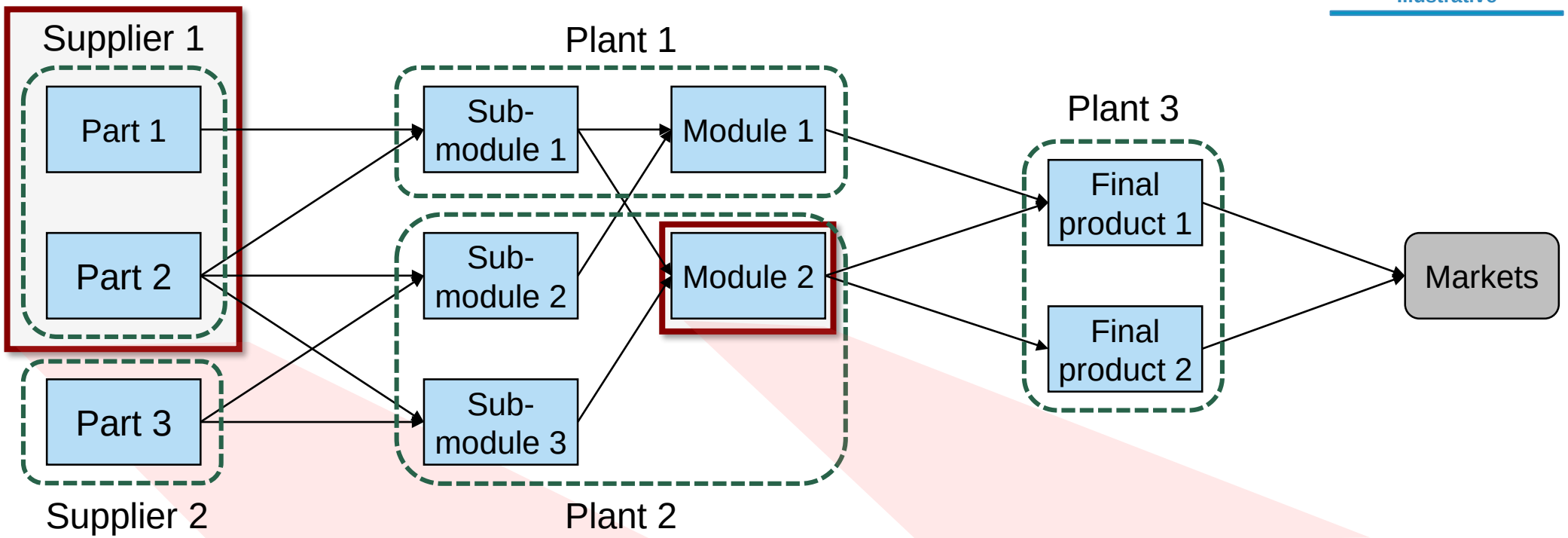


- If the TTS of a particular node is smaller than the expected time to bring the node back to full functionality (TTR), the disruption will expose the supply chain to financial and operational problems.

Source: Figure adapted from Simchi-Levi et al. (2015)

For a given Time-to-recover value at a particular node, the impact of the disruption can be evaluated

Illustrative



Disruption of Supplier 1:

Time-to-Recover: **4 weeks**

Impact:

- Sales at risk: 0.8 Mio $
- Service level: 95%

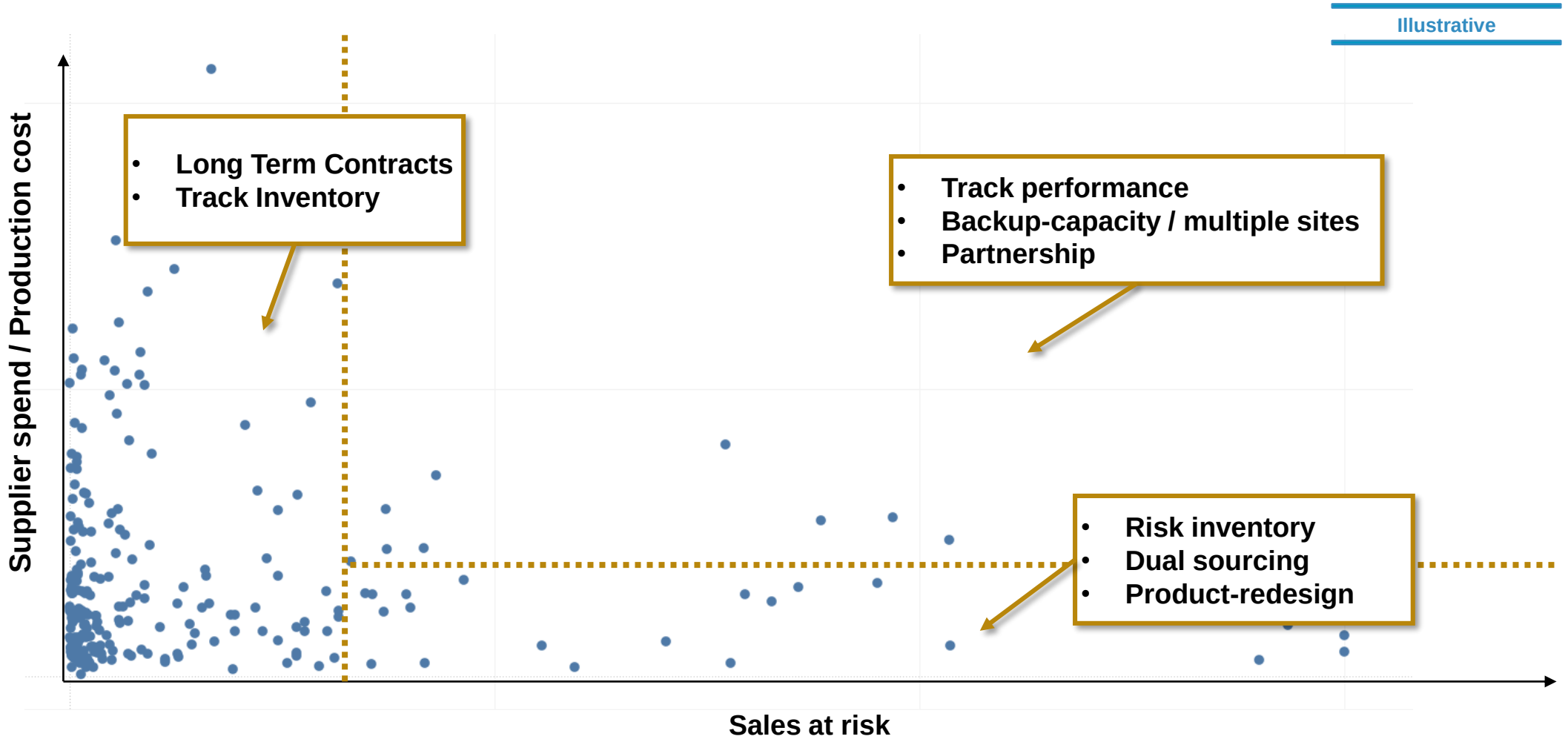
Disruption of Plant 1 – Module 2:

Time-to-Recover: **6 weeks**

Impact:

- Sales at risk: 2.2 Mio $
- Service level: 55%

Data-driven supply chain segmentation and definition of risk mitigation strategies



Source: Figure adapted from Simchi-Levi et al. (2015)

What drives the criticality of a supply chain node?

The **financial and operational impact** of a disruption depends on:

- **Inventory** (at this node and other nodes in the supply chain)
- **Capacity** at other nodes (multi-sourcing, possible product substitution)
- **Demand** volume for the parts or products processed at this node (either direct or indirect demand)
- **Supply chain structure** (a disruption of a node close to the customer tends to have a lower time-to-shortage)
- **Bill of materials** (how many other nodes are affected by the disrupted node)
- **Financial value** of the affected end-products (more critical if the disrupted node is an input for high-price products)

References

- Brandon-Jones, E., Squire, B., Autry, C. W., and Petersen, K. J. (2014). A contingent resource-based perspective of supply chain resilience and robustness. Journal of Supply Chain Management, 50(3), 55-73.
- Sheffi, Y. and Rice Jr, J. B. (2005). A supply chain view of the resilient enterprise. MIT Sloan management review.
- Simchi-Levi, D. (2015). Find the weak link in your supply chain. Harvard Business Review, 2-5.
- Simchi-Levi, D., Schmidt, W., Wei, Y., Zhang, P. Y., Combs, K. and et al. (2015). Identifying risks and mitigating disruptions in the automotive supply chain. Interfaces, 45(5), 375-390.

Agenda

1. Resilience and risk analysis in supply chains
2. Case study: E2E risk app for the supply chain of a internet service provider

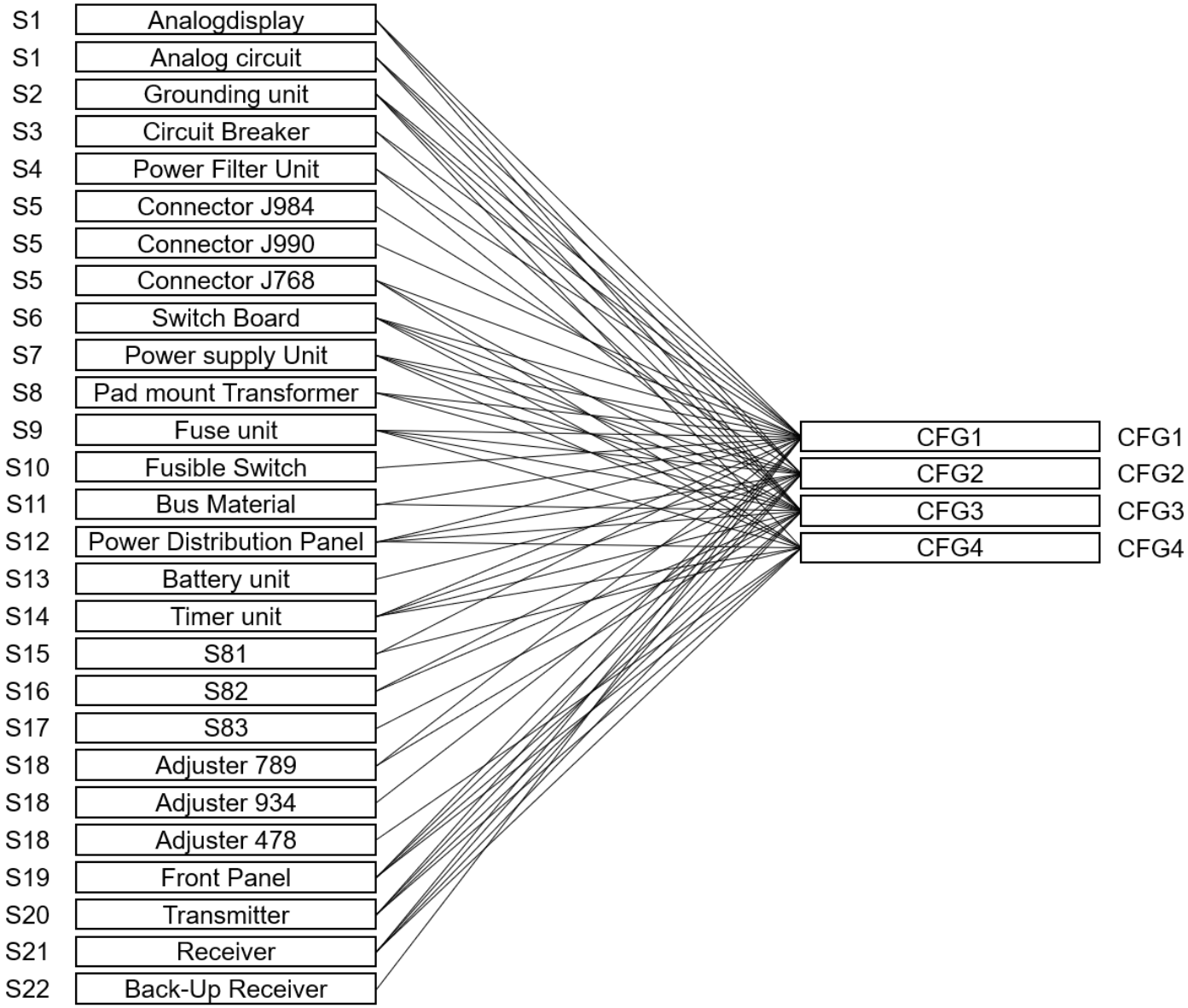
Interactive case study: Risk analysis for the supply chain of an internet service provider

Case Background

- The data for this case is based on Golany (2014) and is inspired by the network of Verizon. The supply chain for network infrastructure is experiencing significant growth and becoming increasingly global and extensive. This growing complexity underscores the need to assess the vulnerability of the supply chain to potential disruptions, the time required for recovery, and the impact on end consumers.
- The scope of the pilot risk analysis focuses on 27 key components, purchased from 22 different suppliers (S1 to S22), which are assembled into 4 different configurations (CFG1 to CFG4) and sold to customers. The objectives of the analysis are to review current risk management practices, identify the most critical items, and assess the financial and operational impact of disruptions. The network structure and collected data are shown on the next slides.

Source: Golany, Y. S. (2014). Enhancing service providers reliability by mitigating supply chain risk: The case of telecommunication networks. Master Thesis MIT.

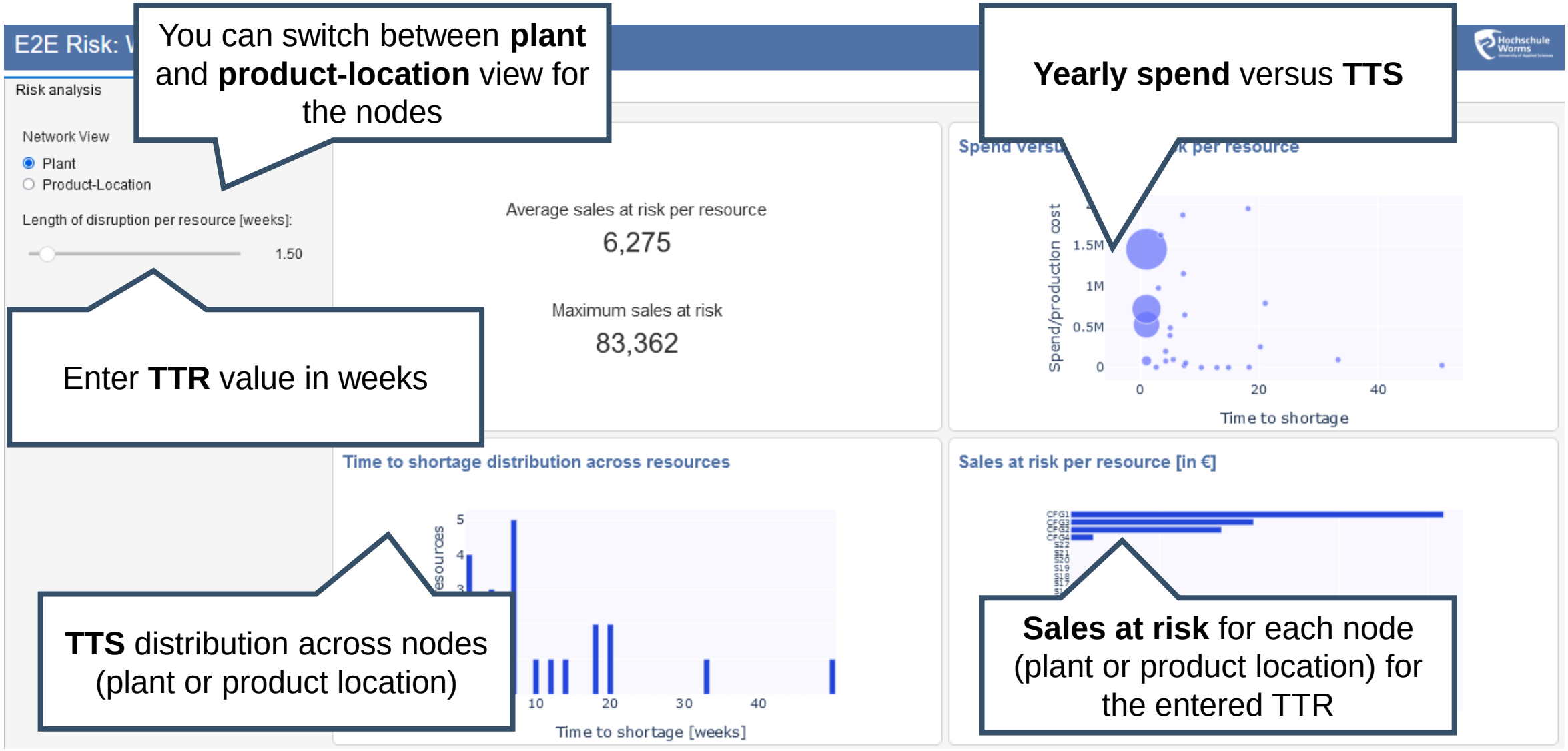
Interactive case study: Network structure



Interactive case study: Data

Item Name	Vendor	Cost per stage	Sales price	CFG1	CFG2	CFG3	CFG4	Inventory	Capacity	Demand per week
Adjuster 478	S18	0.01		0	0	0	2	3060	15	
Adjuster 789	S18	0.01		2	0	2	0	2632	244	
Adjuster 934	S18	0.01		0	2	0	0	940	77	
Analog circuit	S1	56		1	1	1	0	856	160	
Analogdisplay	S1	158		1	1	1	0	352	160	
Back-Up Receiver	S22	125		1	0	0	0	300	82	
Battery unit	S13	15		0	1	0	0	1740	38	
Bus Material	S11	0.1		2	0	1	0	2568	204	
CFG1	CFG1	372	2223	1				75	82	75
CFG2	CFG2	288	1928		1			35	38	35
CFG3	CFG3	384	2276			1		36	39	36
CFG4	CFG4	228	1454				1	7	7	7
Circuit Breaker	S3	44		1	0	1	0	2128	122	
Connector J768	S5	0.1		2	0	3	2	444	299	
Connector J984	S5	0.2		0	3	0	0	1244	115	
Connector J990	S5	0.1		3	0	0	0	488	247	
Front Panel	S19	25		1	1	1	1	492	168	
Fuse unit	S9	0.1		1	1	1	1	1412	168	
Fusible Switch	S10	1		1	0	0	0	1296	82	
Grounding unit	S2	3		1	1	1	1	972	168	
Pad mount Transformer	S8	85		1	1	1	0	940	160	
Power Distribution Panel	S12	10		1	1	1	1	496	168	
Power Filter Unit	S4	17		1	0	1	0	500	122	
Power supply Unit	S7	7		1	1	1	1	1008	168	
Receiver	S21	235		1	1	1	1	936	168	
S81	S15	45		6	0	0	6	3060	541	
S82	S16	44		0	6	6	0	852	468	
S83	S17	35		0	0	6	0	856	237	
Switch Board	S6	99		1	1	1	1	3060	168	
Timer unit	S14	12		1	1	1	1	4936	168	
Transmitter	S20	245		1	1	1	1	2616	168	

The E2E risk app: Wireless



You can switch between **plant** and **product-location** view for the nodes

Yearly spend versus **TTS**

Enter **TTR** value in weeks

TTS distribution across nodes (plant or product location)

Sales at risk for each node (plant or product location) for the entered TTR

Risk analysis for the supply chain of an internet service provider: Tasks

The current risk management approach is spend-driven, i.e., most attention is paid to suppliers and items with high spend. Additionally, risk managers at the company estimate that supply disruptions can be resolved within 4 to 6 weeks.

You have agreed on the following approach for this risk analysis:

- Identify critical suppliers
- Identify the most critical items of suppliers
- Evaluate the financial impact for critical suppliers and items

- In addition, the company seeks your advice regarding the effectiveness of their spend-driven approach to risk management. They are also interested in understanding the effort required for collecting the information needed for calculating metrics such as TTS and Sales at Risk.