There are two key phenomena that affect multiple-stage supply chains

- Floating bottlenecks

- Stage-spanning bottlenecks

- Floating bottlenecks

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Probability</th>
<th>Demand</th>
<th>Stage 1 Stand Alone Shortfall</th>
<th>Stage 2 Stand Alone Shortfall</th>
<th>Supply Chain Shortfall</th>
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<tbody>
<tr>
<td>1</td>
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<td>100</td>
<td>50</td>
<td>150</td>
<td>50</td>
</tr>
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<td>100</td>
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<tr>
<td>Expected Shortfall</td>
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<td>25</td>
<td>50</td>
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The expected shortfall is larger than the maximum expected stand-alone stage shortfall as the bottleneck floats between stages.
• Stage-spanning bottlenecks

These two phenomena are called inefficiencies
Simulation shows that these inefficiencies can significantly affect a supply chain’s performance.
A pairs strategy performs much worse than a total flexibility strategy.

Figure 10
Configuration Loss for Pairs Configuration
Chain configurations offer very good protection against the inefficiencies.
A chain strategy performs very well.

Figure 13
Configuration Loss for Chain Configuration

- Configuration Loss
- Number of Stages

For $h=3$, the maximum configuration loss was 0.34%.
A chain strategy performs very well.

Figure 14
Configuration Loss for Chain Configuration

- h=3 Chain
- h=2 Chain
- Pairs
If the number of stages or the number of products is very large, then an $h=3$ chain strategy may be advisable.

**Figure 15**
Configuration Loss for $h=2$ Strategy as the Number of Stages and Products Increase
Flexibility guidelines for single-stage supply chains

• Try to create chains that encompass as many plants and products as possible (ideally all plants and products would be part of one single chain)
• Try to equalize the number of plants (measured in total units of capacity) to which each product in the chain is directly connected
• try to equalize the number of products (measured in total units of expected demand) to which each plant in the chain is directly connected.
Flexibility guidelines for multiple-stage supply chains

- The guidelines for single-stage supply chains should be followed to create a chain structure for each of the supply chain stages.
- In supply chains with a large number of products or stages, additional flexibility is advisable, especially for stages in which the capacity is not much greater than the expected demand.
- This extra layer of flexibility should again be added in accordance with the above guidelines to create another chain structure overlaying the initial chain structure.
The key findings

Multiple-stage supply chains suffer from two types of inefficiencies that affect performance

BUT

A similar strategy of using chain configurations still works very well