

The implications of Additive Manufacturing technology adoption for Supply Chain Resilience

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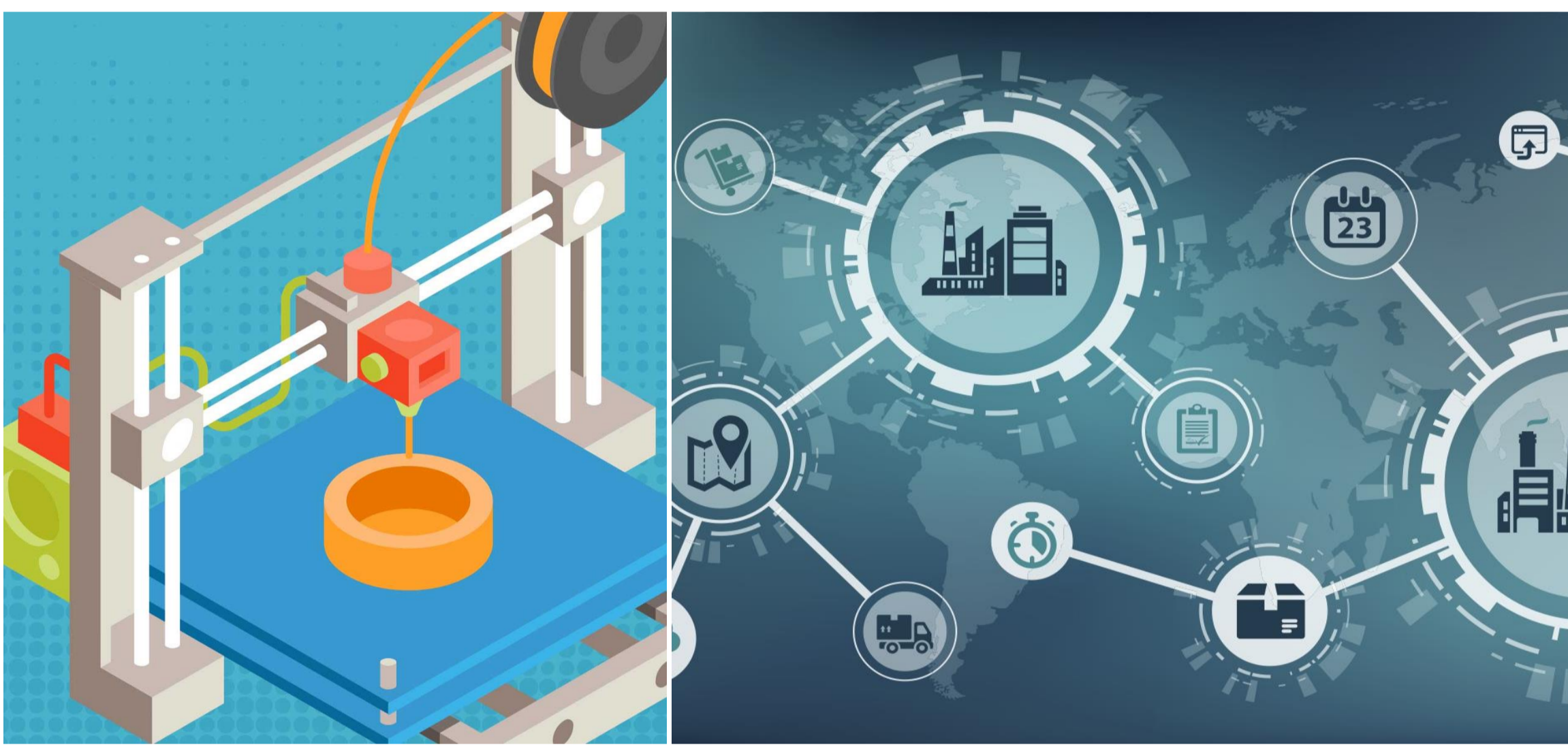
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Additive Manufacturing

- Digital technology that is widely used to solve supply chain problems.
- Uses 3D computer models to directly create objects by incrementally adding layers of materials on a build platform.
- There are adoption barriers (e.g., slow production speed, limited part size, etc.) that hinder the full potential of this technology.



Supply Chain Resilience

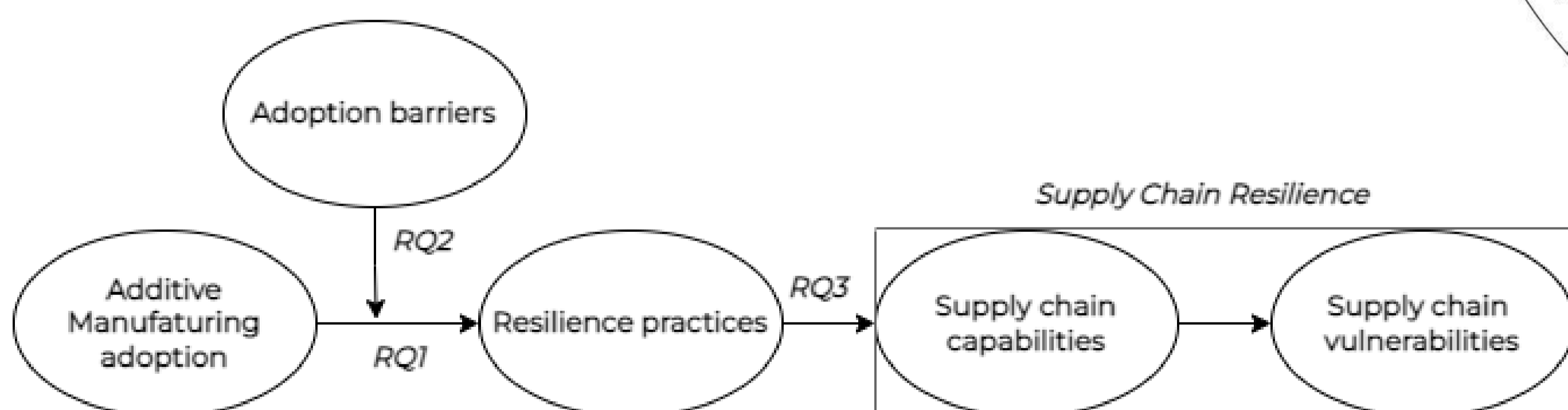
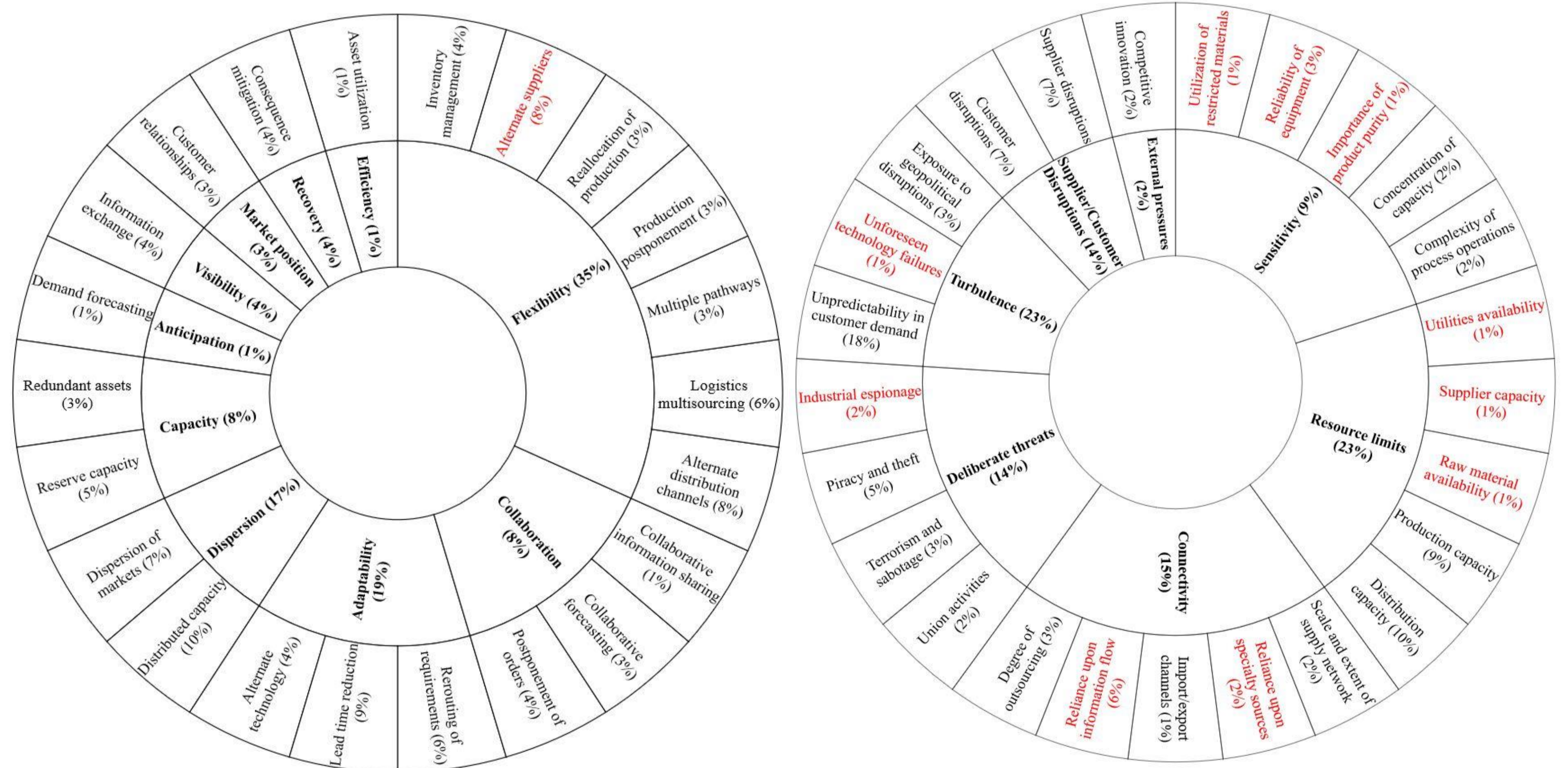
- Resilience is the ability of the supply chain to cope with unexpected disruptions (e.g., natural disasters, pandemics, etc.).
- Supply chain resilience increases as supply chain capabilities increase (e.g., flexibility, adaptability, visibility, etc.) and supply chain disruption vulnerabilities decrease (e.g., resource limits, turbulence, external pressures, etc.).
- Supply chain capabilities indicate to what extent a supply chain is resilient to disruption vulnerabilities.
- Linkages exist between supply chain capabilities and disruption vulnerabilities that influence the level of supply chain resilience.
- Resilience practices are used to build supply chain capabilities and deal with disruption vulnerabilities.
- Wide-spread adoption of additive manufacturing technology affects the resilience practices, influencing the supply chain capabilities used for dealing with the disruption vulnerabilities.

The main objective of the research is to find the most effective resilience practices in the context of additive manufacturing technology adoption for improving supply chain resilience.

Research questions (RQs):

- **RQ1.** How does Additive Manufacturing adoption affect the resilience practices?
- **RQ2.** Which barriers inhibit the effects of additive manufacturing adoption on the resilience practices?
- **RQ3.** How does AM adoption influence certain supply chain capabilities and vulnerabilities via resilience practices?

Projections for the extent to which additive manufacturing adoption affects different supply chain capabilities and vulnerabilities



Conceptual model

Main research steps taken:

- ✓ A systematic search and review is conducted to propose a framework.
- ✓ A mixed-methods approach comprised of case study and explanatory survey is taken to validate the framework.
- ✓ An Additive Manufacturing-Supply Chain Resilience Practices (AM-SCRP) framework is derived based on practice-based knowledge from industry.

Partial representation of the AM-SCRP framework

Additive manufacturing		Resilience practices	Supply chain resilience	
Features	Barriers		Supply chain capabilities (capability subfactors)	Supply chain vulnerabilities (vulnerability subfactors)
Fast production setup Tool-less manufacturing Fewer materials and inventory Digital inventory	Slow production speed Low throughput rate Excessive post-processing requirements Unstable AM processes ICT inadequacies	→ Change the production schedules	→ Flexibility (Production postponement)	→ Turbulence (Unpredictability in customer demand)
Distributed manufacturing On-demand manufacturing Design freedom Part consolidation Rapid prototyping	Excessive post-processing requirements		→ Flexibility (Production postponement)	→ Supplier/Customer Disruptions (Customer disruptions)
On-demand manufacturing Small batch production Automated manufacturing Economies of technology	Limited build volumes Low throughput rate Lack of multi-material printing High cost of AM processes High cost of industrial-grade AM machines	→ Use maximum capacity	→ Adaptability (Lead time reduction)	→ Resource limits (Distribution capacity)
Rapid prototyping Rapid manufacturing Tool-less manufacturing Fast production setup Part consolidation	Excessive post-processing requirements Slow production speed High cost of industrial-grade AM machines Unstable AM processes		→ Adaptability (Lead time reduction)	→ Turbulence (Unpredictability in customer demand)
		→ Reduce response time	→ Efficiency (Asset utilization)	→ Turbulence (Unpredictability in customer demand)
			→ Adaptability (Lead time reduction)	→ External pressures (Competitive innovation)
			→ Adaptability (Lead time reduction)	→ Turbulence (Unforeseen technology failures)

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