

# **SESA6085 – Advanced Aerospace Engineering Management**

Lecture 18

2024-2025

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# Module Recap

- Probability theory
  - Capturing uncertainty e.g. PDFs
  - The impact of uncertainty e.g. MC, RBD, FTA
  - Design in the presence of uncertainty
  - Project uncertainty management
- 
- We will now consider supply chain management and uncertainty



Moving up the  
business

# Supply Chain Management

# The Definitions

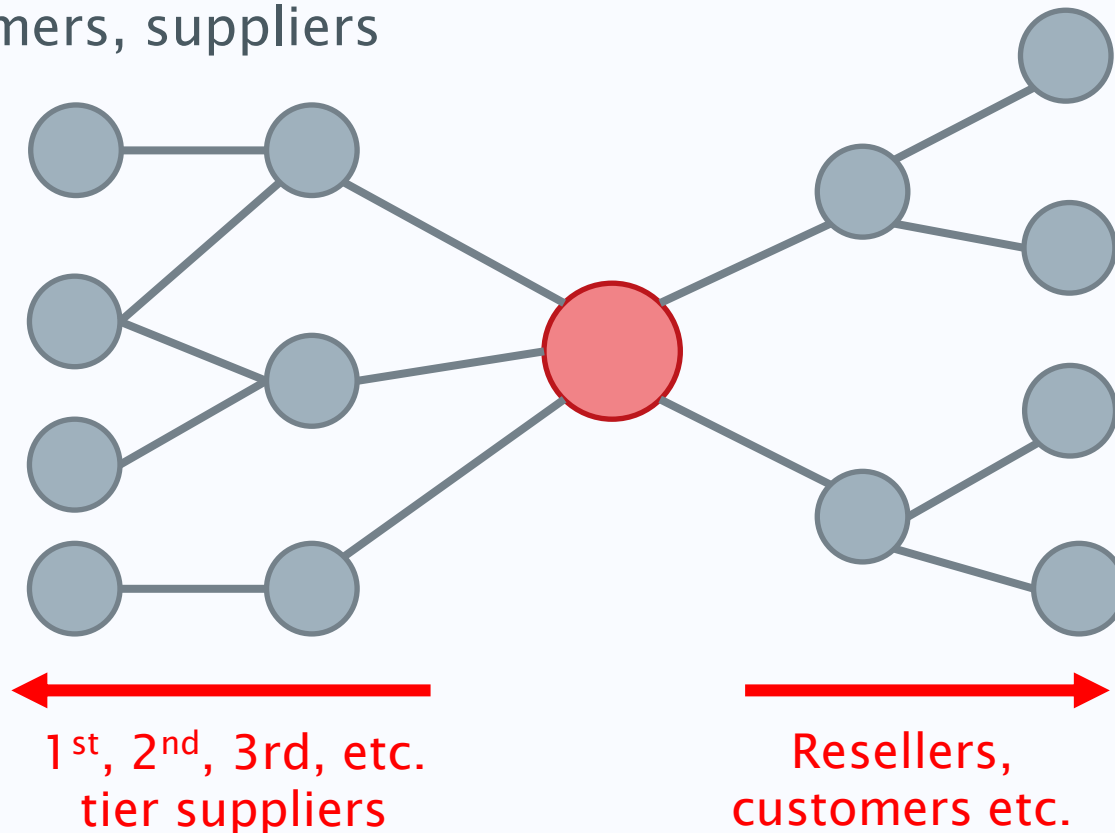
- Supply chain management:

“The management of upstream & downstream **relationships** with suppliers & customers in order to deliver superior customer **value** at less cost to the supply chain **as a whole**”

- Note the words in bold, as we will see these are very important when building an effective supply chain

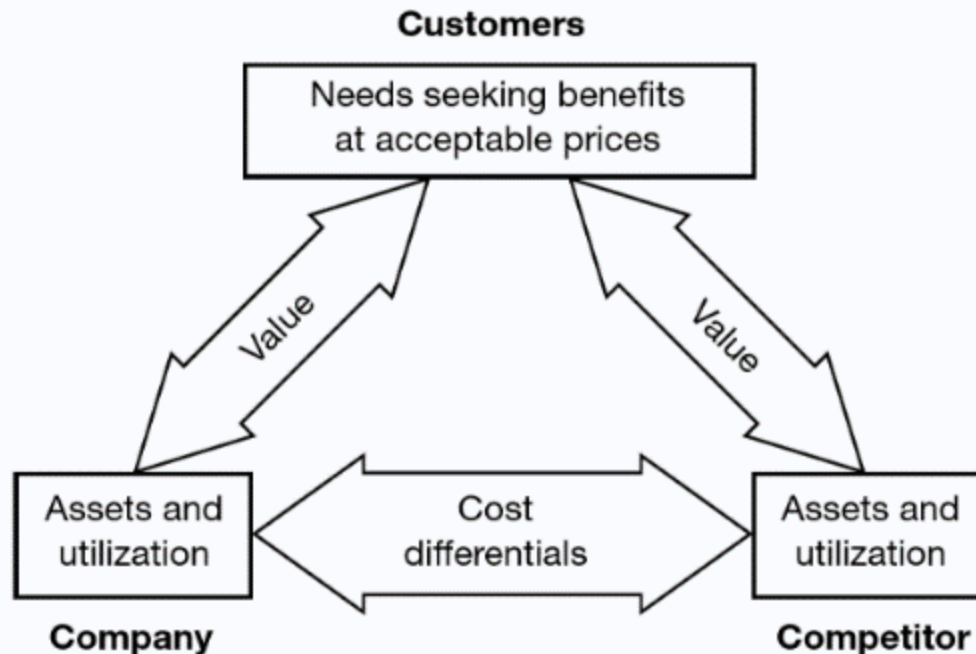
# The Supply Chain

- The typical supply chain is essentially a network between customers, suppliers



# Importance of the Supply Chain

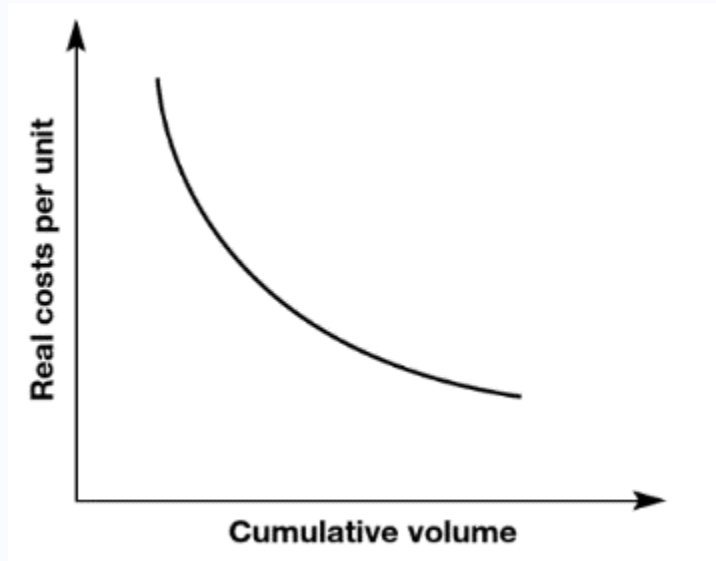
- Why should we care about supply chains?
- Supply chains can if utilised effectively, become a major source of competitive advantage



- Essentially, we want to beat our competitor in terms of cost & value to the customer

# Cost Advantage

- The traditional view is that unit costs are driven down through volume or scale
  - The “big is beautiful” view of the world



- This view ignores the world outside of the business
- Better supply chain management can increase efficiency & productivity and therefore also reduce unit cost

# Value Advantage

- Products are purchased for what they will deliver, not for the product itself
- If the product cannot distinguish itself in the marketplace it will tend to be viewed as a commodity – the sale goes to the cheapest supplier
  - This places importance on adding additional values
- Product differentiation is one way to achieve added value
  - Different options on a model of car appeal to different buyers



# Value Advantage



EXTERIOR | INTERIOR\*

☐ No Extras Required



Black Painted Roof Black body styling kit  
£400 (RRP) <sup>11</sup>

MORE DETAILS ⓘ

REMOVE ⓧ



18" Alloy Wheels - Shadow Black Machined Finish  
£600 (RRP) <sup>12</sup>

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View More Extras ⓘ

SUMMARY >

# Value Advantage

- As technologies converge physical differentiation becomes more difficult
- The focus shifts toward services i.e. differentiation through augmented offerings
  - Delivery service, after-sales service, financial packages, technical support etc.
- Our definition of the supply chain is not only focused on what goes into a product but who uses it
- The supply chain is therefore critical to delivering some of these augmented offerings which increase value

# Value Advantage



Kia cars



# Rolls-Royce®

RR's power by the hour

**With up to £1,500 towards your deposit at  
up to 5.9% APR Representative Finance\***

## Ibiza PCP Offer



- £1,000 deposit contribution at 5.9% APR Representative Finance\*
- Two services for £199\*

## Arona PCP Offer



- £1,500 deposit contribution at 4.9% APR Representative Finance\*
- Two services for £199\*

## Leon PCP Offer

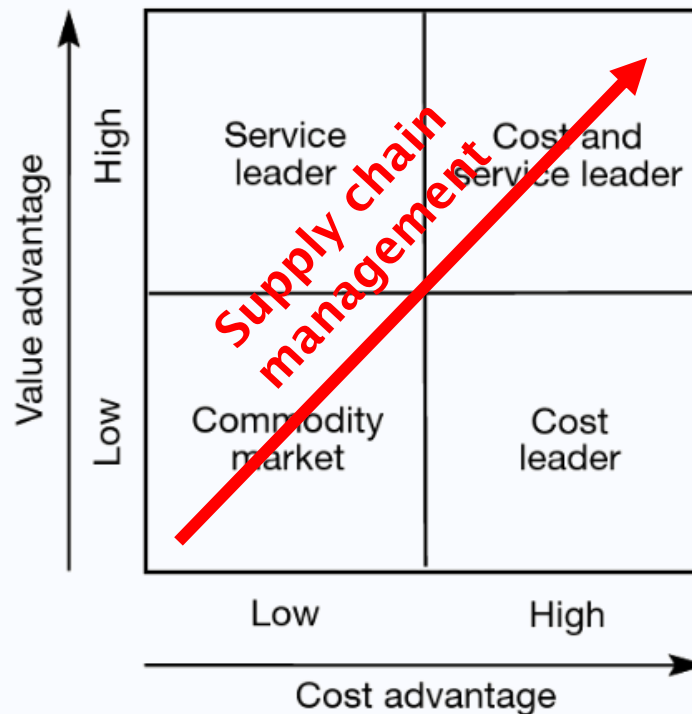


- £1,000 deposit contribution at 5.9% APR Representative Finance\*
- Two services for £199\*

Seat cars

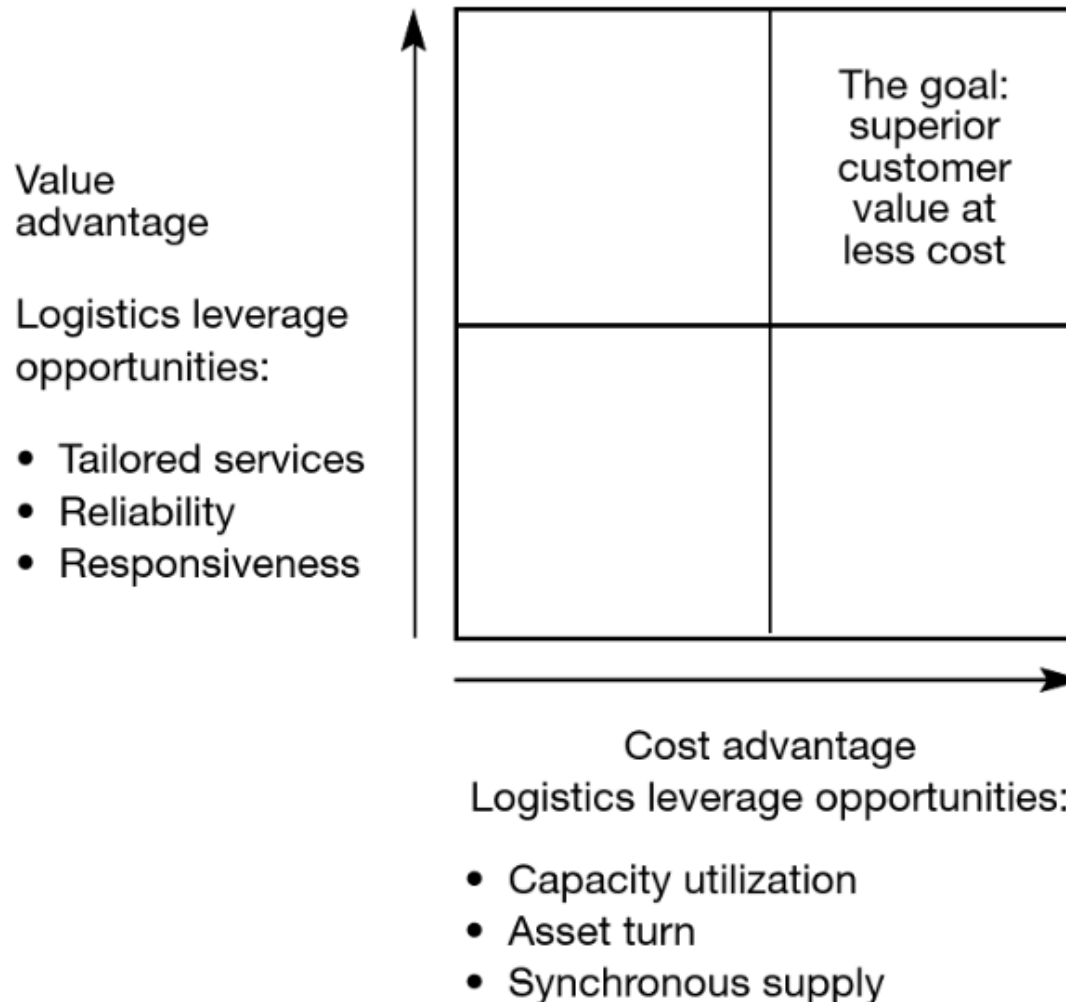
# The “High Ground”

- We can represent this strive for competitive advantage as follows...



- Clearly, we want to be in the top right corner and effective supply chain management can help us get there

# The “High Ground”



A still from Star Wars: Episode III - Revenge of the Sith showing Obi-Wan Kenobi in his Jedi robes, standing in a volcanic landscape with lava in the background. He is holding a blue lightsaber in his right hand and has his left hand outstretched.

**It's over! I have the superior  
supply chain network!**



# Current Challenges

- The current challenges in supply chain management & logistics can be summarised as...
  1. New rules of competition
  2. Turbulence & volatility
  3. Globalisation of industry
  4. Downward pressure on price
- We'll now look at these in turn

# New Rules of Competition

- Moving away from isolated company against company
  - Strong brands with aggressive advertising & sales
- Towards an era of “supply chain competition”
- Aiming to create a value delivery system better than the competition which is:
  - More responsive to fast-changing markets
  - More consistent and reliable in the delivery of value
- This leads to companies attempting to manage their core processes better than their competitors do
  - Focus on new product development with outsourcing
- Product life cycles are becoming shorter
  - Shorter life cycles require shorter lead times



# Globalisation of Industry

- There is a continued trend towards globalisation
  - Materials & components sourced and assembled worldwide
  - Cost reduction e.g. lower labour costs
- Naturally, this leads to logistics becoming an increasingly important factor in determining profitability
  - Profit/loss can hinge on the optimisation of a global pipeline
- Supply chains lengthen
  - Striking the balance between locations for global manufacture/assembly and local market requirements can be very important
  - Shortening product life cycles make this more important
  - Greater buffer stock requirements

# Turbulence & Volatility

- Volatility and turbulence around the world lead to increased levels of uncertainty
  - Economic factors
  - Geo-political upheavals
  - Global supply chains
- Forecasting now becomes increasingly difficult
  - Uncertainty in the levels of inventory to build/hold which has implications on profitability
- Uncertainty impacts both demand and supply

# Downward Pressure on Price

- Prices have been driven down by
  - Low-cost manufacturing bases e.g. China
  - Removal of trade barriers
  - Deregulation
  - Internet e.g. price comparison
- The supply chain offers a way in which cost reductions outside a business can be realised in order to stay profitable
  - E.g. reduction in inventory size and move to “just in time”

# Challenges Reviewed

- At its core, the supply chain of the future should be:
  - Responsive
  - Consistent
  - Reliable
  - Robust to uncertainty
  - Optimal
- These are terms we are already very familiar with in this module

# Supply Chain Uncertainty

# Supply Chain Vulnerability

- We define supply chain vulnerability as:  
“An exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain”
- Modern supply chains tend to be vulnerable because of:
  - A focus on efficiency rather than effectiveness
  - Globalisation
  - Focused factories & centralised distribution
  - Outsourcing
  - Reduced supplier base
- Let's consider each of these in turn

# Efficiency vs. Effectiveness

- Prevailing business models in the 20<sup>th</sup> century focused on achieving greater supply chain efficiency
  - This typically resulted in inventory reduction
  - Shifting to “just in time” (JIT) practices – lean manufacturing
- This leads to an organisation becoming increasingly dependent on suppliers
  - While fine in a stable market this leads to problems if a market is volatile
- Today the aim should be to balance lean with agile practices
  - If there is an issue the organisation can respond/adapt quickly

# Focused Factories & Centralised Distribution

- Trade deals, single markets etc. remove barriers to the flow of products across borders
  - Leading to centralisation of production and distribution
  - Economies of scale can be leveraged to drive down unit cost
- Focus factories specialise in the production of a single item
  - Compared to all products at every site this is cheaper
  - However, products must now travel further – increasing cost
  - Across many borders – increasing geo-political risk
  - Factory flexibility is lost – reduces supply chain agility
- It's a similar issue with centralised distribution



# Outsourcing

- We've briefly discussed organisations outsourcing activities
  - Distribution, accounting, manufacturing, IT etc.
  - Some companies are now effectively “virtual”
- This trend is driven by the logic that an organisation is more likely to succeed by focusing on what it is good at
  - Network organisations or confederations of businesses
- Outsourcing however brings:
  - A loss of control
  - Failure of one link in a chain can have knock-on consequences
  - The more links in the network the greater the risk

# Reduced Supplier Base

- The trend in recent years is to reduce the suppliers that an organisation purchases from
  - Some organisations only use a single supplier – “single-sourcing”
  - Mergers & acquisitions can also drive this
- This has benefits e.g. increased communication leading to an improved JIT process, reduced inventory and costs
- However, it exposes the organisation to what is effectively a single point of failure

# Supply Chain Risk Profile

- Business continuity management (see later lectures) can solve some of these issues but tends to focus on internal operations and not on the supply chain
- Supply chain risk profiling aims to understand the risks in the supply chain to the company
  - Identifying where the greatest vulnerabilities lie and the probability of disruption occurring
- The literature tells us that risk is quantified as...  
$$\text{Supply chain risk} = \text{Probability of disruption} \times \text{Impact}$$
- This is based on our classic probability impact grid
  - As discussed in our previous lectures this has a number of issues e.g. an agreed definition of impact and probability

# Supply Chain Risk Profile

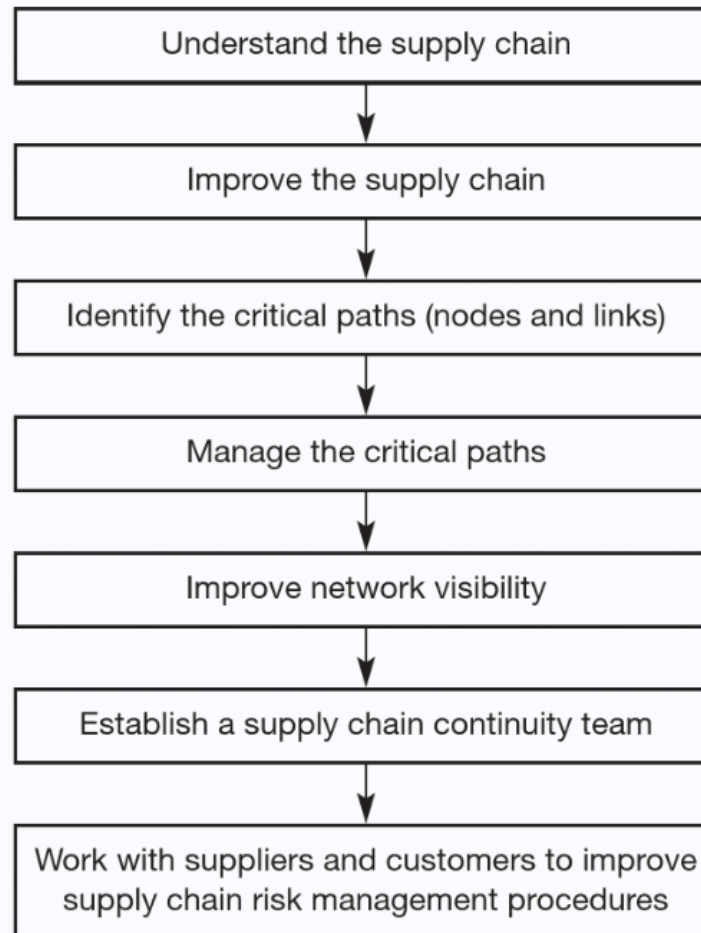
- Effectively our profile is attempting to determine the “critical path”
  - Does this sound familiar??
- If we were to quantise impact as the lead time on a product, we can create a network where the probability of disruption at a node is defined e.g. by a distribution
  - Very similar to the way in which project duration uncertainty is determined
- Importance metrics can even be devised to indicate how important a node is
  - Recall our reliability importance metrics

# An Effective Profile

- For the risk profile to be effective disruption should be considered from five sources
  1. Supply - How vulnerable is the organisation to disruptions in supply?
  2. Demand – How volatile is demand?
  3. Process – How resilient are processes & what are the sources of variability, bottlenecks and capacity?
  4. Control – What is the impact of internal control processes? How timely is any data used?
  5. Environmental – How vulnerable is the chain to external factors? The impact of rare external events needs assessing

# Managing Supply Chain Risk

- There are seven stages to the management of supply chain risk



# Understand The Supply Chain

- Awareness of the supply chain structure & dependences is often lacking in organisations
- Mitigation of risk requires a detailed understanding of not only the structure but what is happening within that structure



**JOHN DEERE**

- John Deere, for example, employs a software tool to monitor first, second and third tier suppliers for issues in order to mitigate risk

# Improve the Supply Chain

- This includes:
  - Simplification
  - Improving process reliability
  - Reducing variability
  - Reducing complexity
- Supply chains tend to evolve organically and not actually be planned
- Process variability can be addressed through six sigma methodology
  - Aiming to reduce defect probability to 3.4 per million



# Identification of Critical Paths

- Supply chain risk profiling can be used to identify critical paths
  - FMEA could also help with this
- Likely characteristics of such paths include
  - Long lead times from order to delivery
  - Single sources of supply with no short-term alternative
  - Dependence on specific infrastructure e.g. ports, IT
  - Bottlenecks
  - High levels of risk e.g. supply, demand, process, control & environmental

# Manage Critical Paths

- Once identified these paths should be effectively monitored and managed this includes:
  - The development of contingency plans in the event of failure
  - Re-engineering the supply chain
  - Process control to monitor the supply chain e.g. John Deere
  - Adding capacity to remove bottlenecks – additional suppliers
  - Increasing inventory if alternative suppliers cannot be found

# Improve Network Visibility

- Entities within the supply chain network may be unaware of up and downstream status of inventory through the chain
  - Delays problems in the network becoming visible
- A supply chain “control tower” can constantly monitor complex supply chains e.g.
  - Inventory levels
  - Delivery times
  - Supplier performance
- RFID, or similar technologies, allow products to be tracked through the entire chain
- Satellite tracking allows products to be tracked in transit
- The real challenge here is the desire to share information

# Establish A Supply Chain Continuity Team

- Managing and improving a supply chain in itself requires resources
- A permanent supply chain continuity team is one way in which this can be achieved
  - This is similar to the business continuity team already in place in most large organisations (see later lectures)
- Such a team is cross-functional and is able to undertake detailed analysis and implement changes to reduce risk

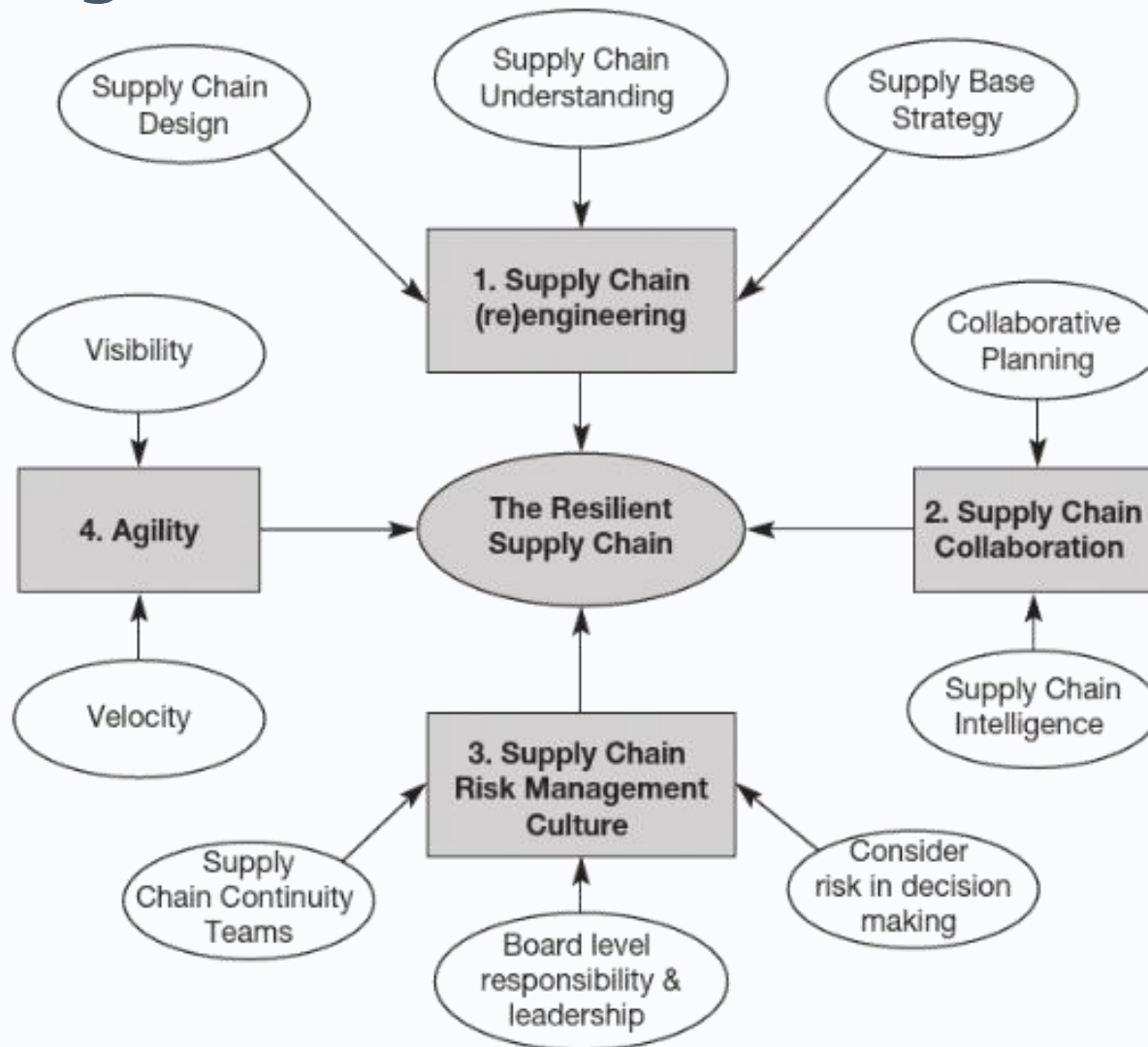
# Work With Suppliers & Customers

- All organisations within the chain should take risk management measures
  - A single organisation cannot effectively manage an entire chain
- Each organisation could take responsibility for managing risk between themselves, their suppliers and customers
  - This effectively covers the entire network
- Collaboration and sharing of information is vital
- Supplier development can also be employed
  - Customers help to develop and mitigate risk in their suppliers
  - E.g. BAe Systems supply chain relationships in action initiative
- Standards can be imposed on suppliers via the contract
  - This has a ripple effect down the supply chain

# Achieving Resilience

- Achieving supply chain resilience requires the processes to be flexible and agile
  - It's not just about velocity
  - Acceleration (to ramp activities up and down) is important
  - Slack in the system is also necessary
- Resistance – robustness of the chain to avoid shocks which might impact it – e.g. like a shock absorber on a car
- Recovery – the speed at which the chain can return to normal after a disruptive event e.g. quickly finding alternative suppliers

# Achieving Resilience



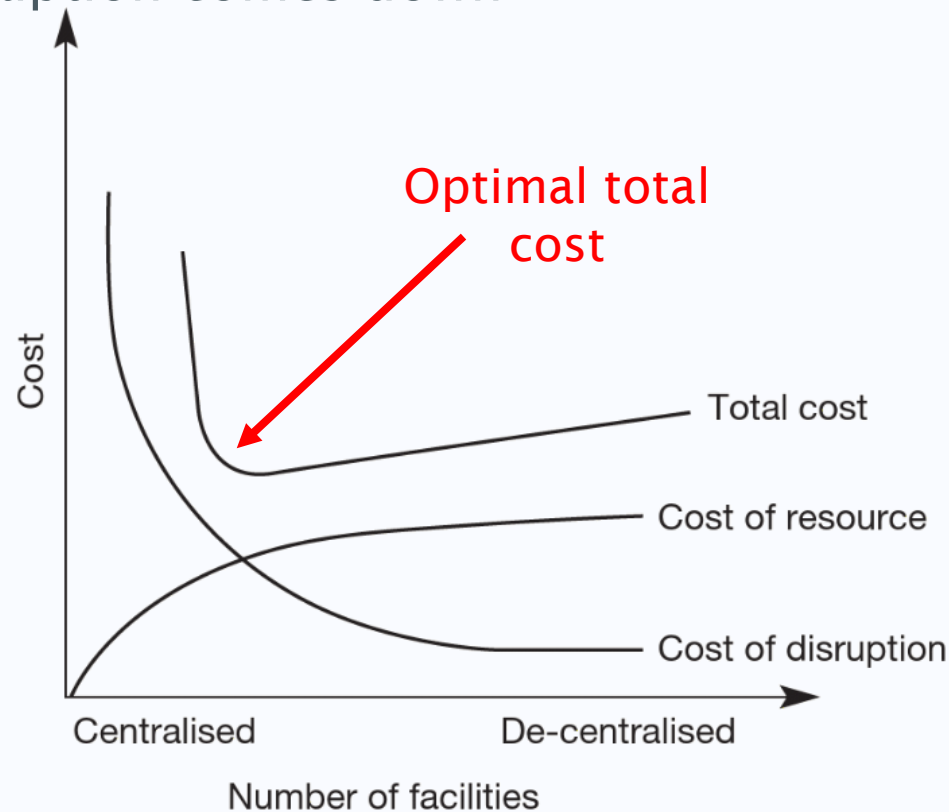
# Supply Chain (Re-)engineering

- Risk is systemic i.e. it's present because of the design
- Often supply chains evolve to reduce costs ignoring risk
- Designing a supply chain from scratch should attempt to include redundancy
  - E.g. removing reliance on a single facility or source
- Naturally there's a trade-off between the cost of introducing such redundancy and keeping costs down
- The supply chain can be designed from the ground up or re-engineered to take this trade-off into account



# Supply Chain (Re-)engineering

- Even though unit costs go up with number of facilities, the cost of disruption comes down



- Too high a level of centralisation may actually have a higher cost

# Supply Chain Collaboration

- High levels of collaboration within the chain breeds resilience
  - Due to the interdependencies within the chain
- This requires a willingness to share information amongst all of the partners
- Increased visibility of what's happening in the chain reduces “bullwhips”
  - Disturbances are magnified because of a lack of visibility
- Pooling of risk knowledge and best practice can also be of benefit
  - E.g. the creation of a supply chain council

# Risk Management Culture

- Disruption from a failure in the supply chain can be significant
- Developing a culture to manage this risk is therefore important
  - Regular reports on business risk profile can be created
  - Supply chain continuity team should be established
  - Contingency plans developed
- Cybersecurity plays a key role here
  - Sharing of information is necessary for effective supply chain management but could result in more cybersecurity holes

# Agility

- The more agile a supply chain is the greater the ability to bounce back and recover
- Agility is enabled by:
  - Visibility – Seeing things sooner enables action to be taken sooner
  - Velocity – Reducing the time it takes to respond
- Investments should therefore be made to improve our supply chain's ability to sense and respond
- Decisions should be made that keep options open
  - Locking the supply chain severely reduces agility

# Conclusions

- Supply chains play a significant role in the unit cost of a product and with careful attention can be used to drive that cost down
- However, blindly driving down unit cost in this manner through globalisation, consolidation etc. can leave the supply chain vulnerable to turbulence and uncertainty
- The optimal, robust, supply chain is one which balances the drive to reduce unit cost with the potential costs of disruption by engineering the chain to improve collaboration and agility
- The mathematical tools taught to date can be used to understand the risk profile of a supply chain and thereby optimise it



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