

BUSI4496

**Supply Chain
Planning &
Management**

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Operations Management
and Information Systems

Nottingham University
Business School

Lecture 10

Planning and Control across
the Supply Chain




01.12.2025



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UNITED KINGDOM • CHINA • MALAYSIA

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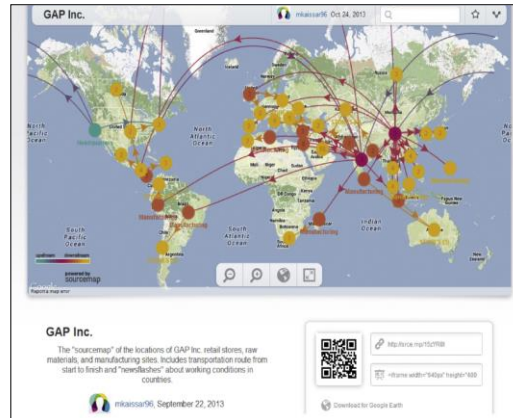
Outline

1. Supply Chain Configurations
2. The Bullwhip Effect
3. Supply Chain Collaboration for Planning
 - Supply Chain Collaboration for Inventory Management
 - Supply Chain Collaboration for Planning and Forecasting
4. Blockchain solutions ?
- Pre-Recorded Self Study Session on Moodle**
5. Supply Chain and Operations Performance Measurement
 - Process Measures
 - Customer Service Measures
 - The SCOR model

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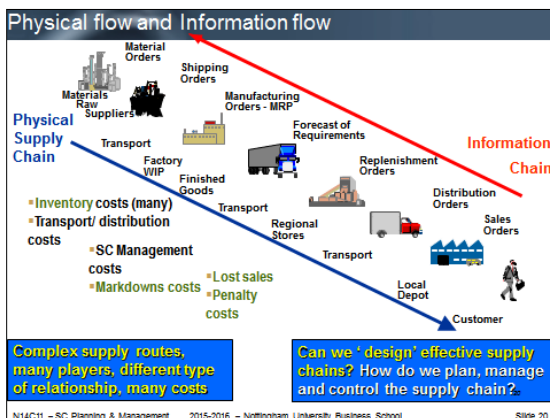
1. Supply Chain Configurations



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Supply Chain Management – definitions from session 1

The Supply Chain

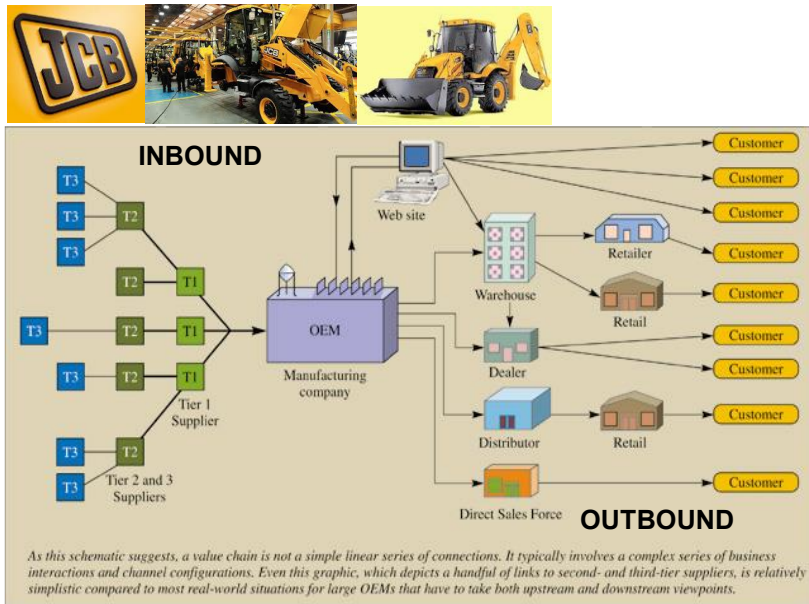


1. Do all supply chains look the same?

2. Do all supply chains have the same problems?

4

A manufacturing supply network



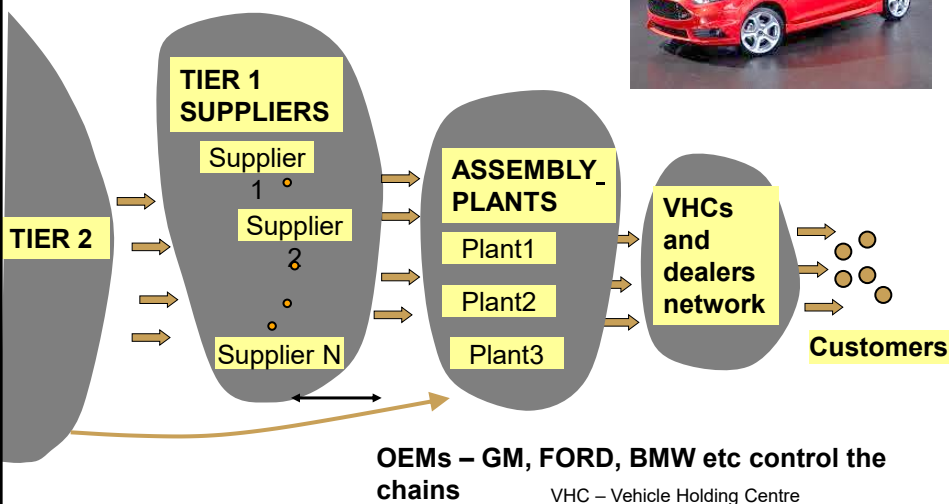
Adapted from: Jacobs R F, Chase R F and Aquilano N J. "Operations and supply management." (2009)

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Supply networks in automotive

- International networks
- Various forms of ownership/ relationships

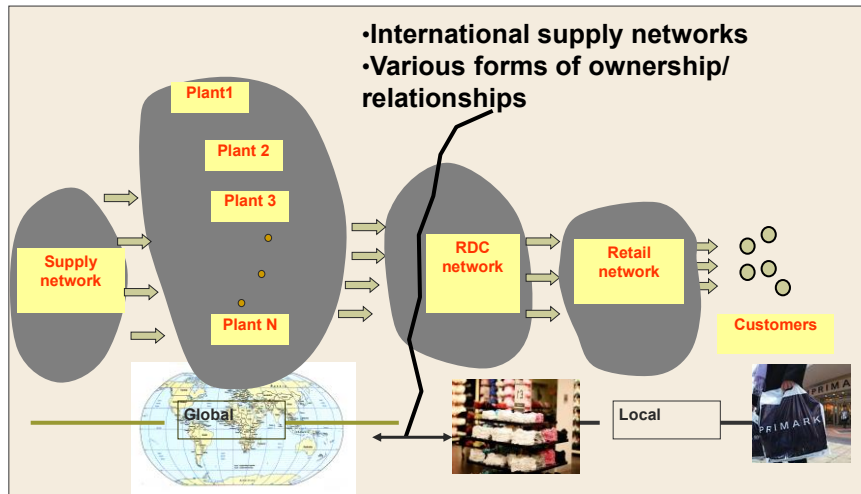


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Supply networks in clothing

Benetton, GAP, M&S, Primark, Zara, different network configurations

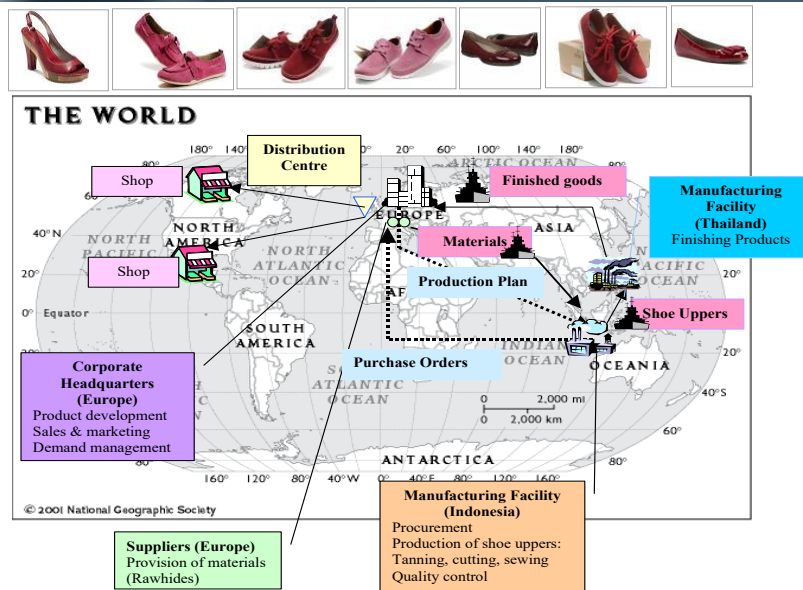


MacCarthy, B. L., & Jayarathne, P. G. S. A. (2010). Fast fashion: achieving global quick response (GQR) in the internationally dispersed clothing industry. In *Innovative Quick Response Programs in Logistics and Supply Chain Management*. Springer.

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International supply network – shoes

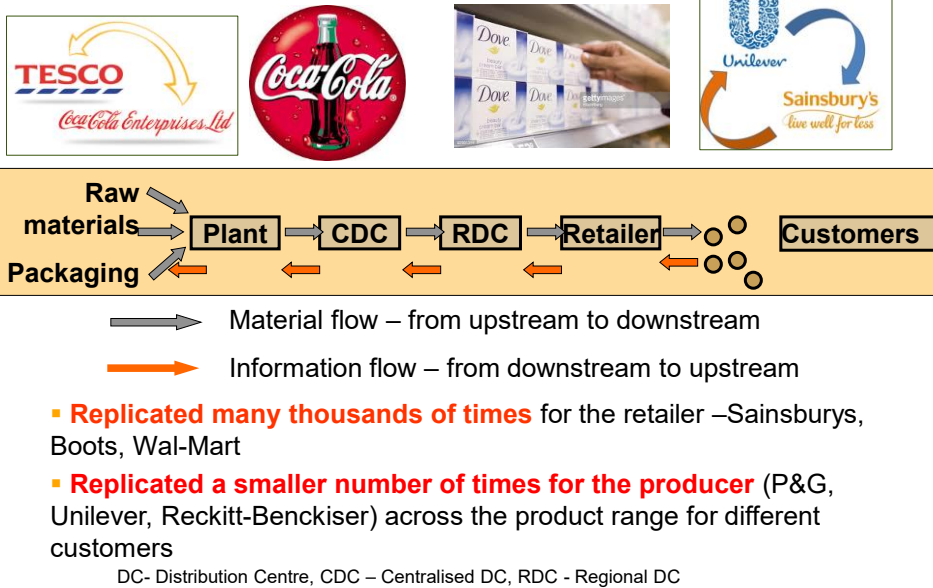


Er and MacCarthy (2006), Managing product variety in multinational corporation supply chains' I. J. of Man.Tech. Management, Vol. 17 (8), 117-1138.

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Typical consumer product supply chain



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Supply Chain Management – definition from session 1

Supply Chain Management

Integrates suppliers, manufacturers, warehouses, distributors, retailers... so that products and services are produced and distributed efficiently, in the right quantities, to the right locations, at the right time, whilst minimizing system-wide costs and satisfying service level requirements.

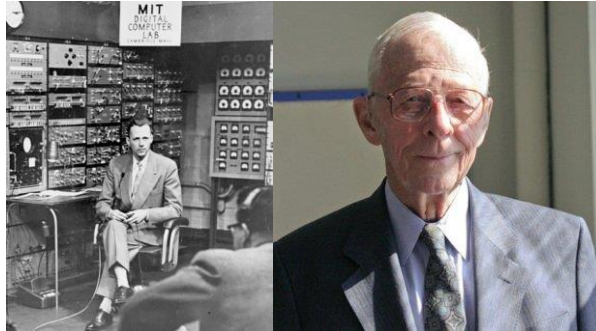
1. What happens when there is no integration?

2. What does integration really mean, how do we do it and why is it difficult?

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2. The Bullwhip or Forrester Effect

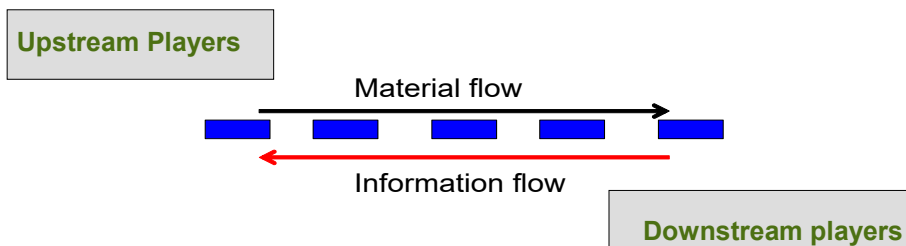


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The Bullwhip Effect

In general **material flows downstream** and **information flows upstream**

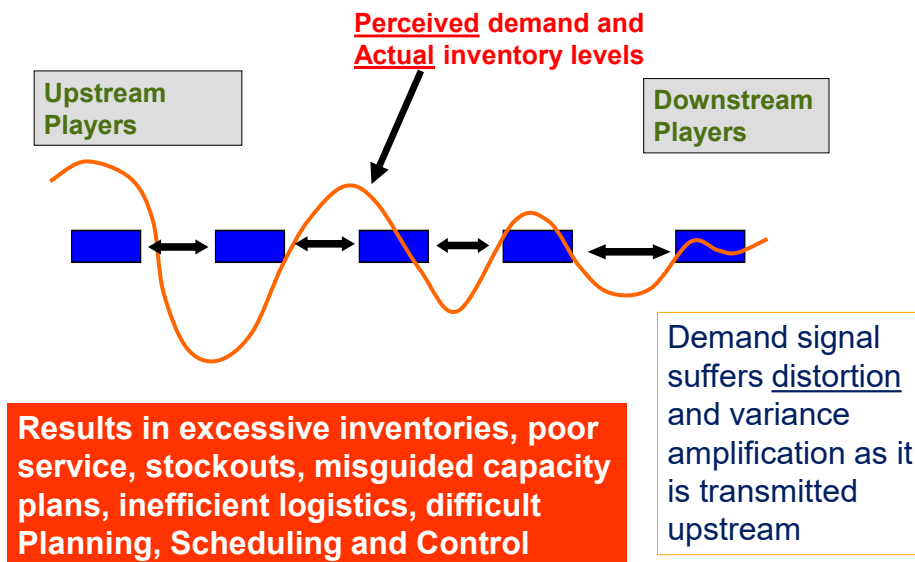


- Supply chains often exhibit **unpredictable dynamic behaviour**
- **Demand distortion/amplification effects** upstream of demand source
- identified by Jay **Forrester** (Industrial Dynamics 1961's)

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Bullwhip Effect – demand signal distortion



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Why does demand signal distortion happen?

- Results from a **combination of factors**
 - **Players operating independently**, responding/forecasting to orders from their nearest downstream customer
 - **Upstream** manufacturing/supply **policies** – **longer** planning and forecasting horizons, **larger** batches
 - Different/ **misaligned** ordering **policies** /timings
 - **Purchasing incentives/penalty free returns**
 - **Compensatory behaviour**
 - **Gaming behaviour**
- **Not all factors present in all supply chains** but many evident in unmanaged, poorly designed chains

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Implications of Bullwhip

- **Confirmed in many supply chains**

- Baby's nappies (P&G))
- HP printers
- DRAM market
- Food and grocery products



- **Problems caused**

- Scheduling in bottlenecks plants
- Control of inventory levels
- Managing human resources
- Excessive admin, fire fighting

<https://www.youtube.com/watch?v=3dXCaRetzdw>

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Mitigating or Eliminating the Bullwhip Effect

The challenge is to design and operate supply chains, **sharing the benefits** from high performance for all players – **win/win**

- **Partnerships, Collaboration and Integration needed to avoid bullwhip**
- **Different forms of collaboration are possible**
- **But they are hard to do!**

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3. Supply Chain Collaboration for Planning



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Supply Chain integration - Inventory Management₁

- **Traditional approach**
 - contract based
 - ‘arms length’ relationship
 - no collaboration
- **Many collaboration approaches**
 - collaboration on inventory management
 - collaboration on planning
- **Most basic- Information sharing**, the supplier and customer work relatively independently but agree to share some demand information to enhance supply chain performance



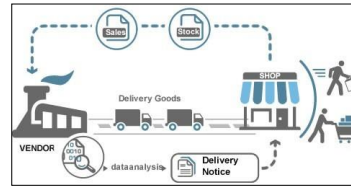
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Continuous Replenishment teams

Continuous replenishment process

- information sharing across supply chain members to match supply and demand as closely as possible
- **All parties focus on ensuring supply**
- Joint teams
- Works best in fast moving consumer products/grocery



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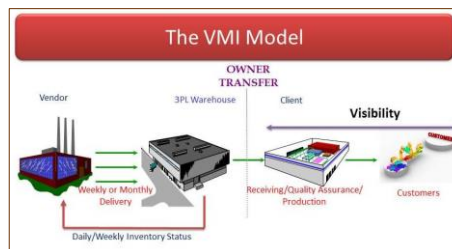
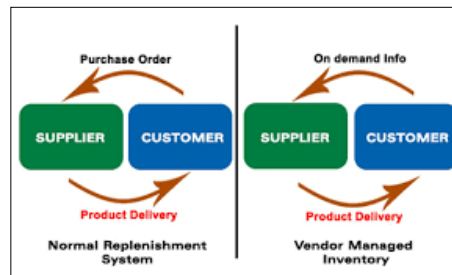
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Vendor Managed Inventory (VMI)

Vendor-Managed Inventory (VMI)

Note: Vendor = Supplier

- VMI is unique in requiring
- 1. transfer of decision making and inventory management responsibilities from the customer to the supplier
- 2. Customer provides the **supplier** with **access to demand information**
- 3. **Supplier decides when** to replenish and **how much**



Production VMI Electronics - Contract Logistics / SCM - YouTube

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Supply Chain Integration - Collaborative Planning (CPFR)

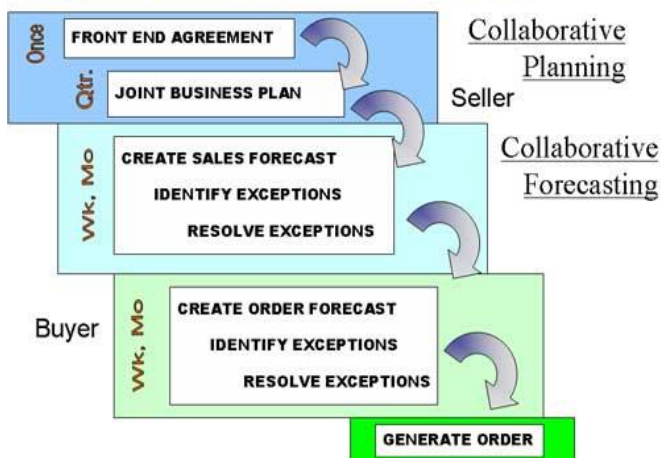
- **CPFR** is a web-based supply chain framework to help supply chain partners to **collaboratively plan**, **collectively forecast** and **replenish inventory** when required.
- CPFR provides a **'roadmap for collaboration'** for partners to **integrate** their demand, supply and execution processes effectively.



ERP systems help with CPFR

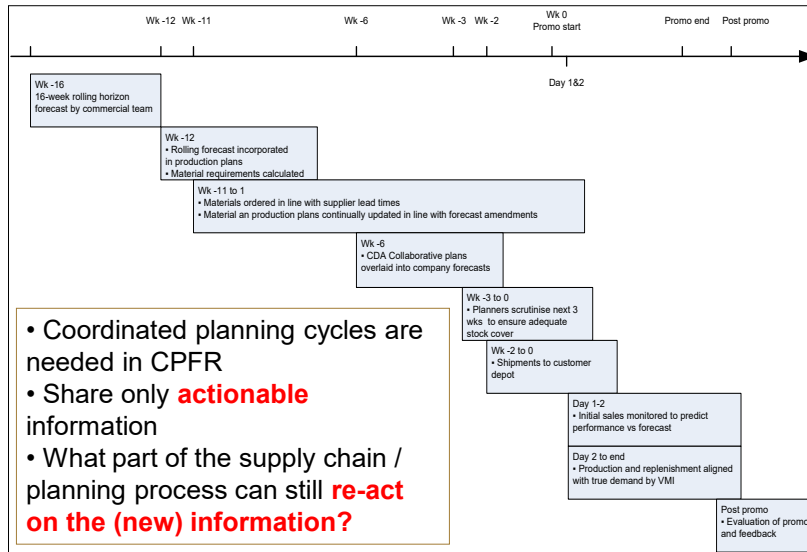
9-Step Original CPFR Model

Original CPFR® Process Model



Source: www.vics.org

Coordinated planning cycles in CPFR



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Supply chain partnerships - requirements

Strategic partnerships needed

- Requires **coordinated working**
 - forecasting, planning and scheduling
 - **by all key players** across the supply chain

Agreements needed

- Procedures, removal of duplication, same terminology, reference numbers etc,
- Handling of priorities
- Sharing forecasts/plans
- Real time SC visibility/traceability
- **Communication channels**
- **Authority/responsibility**

Integration is difficult!

- Power is important in any supply chain
- Poor design, legacy infrastructure
- Risk and revenue sharing challenging
- Service level agreements dominate (SLAs)
- Purchasing and procurement policies
- Supplier development initiatives may be needed
- New digital solutions!

<https://www.e2open.com/resources/the-power-of-the-network/>

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4. Blockchain solutions



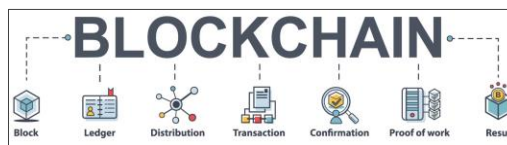
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Blockchain for the supply chain



Blockchain technology harnesses the power of the internet to capture transactions digitally, record them digitally and link them in a chain of blocks of information that is tamper-proof (cannot be changed), and visible in multiple locations across a network, dynamically in (almost) real time.



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Blockchain – what is it?

▪ Blockchain ≠ Bitcoin

- Bitcoin and other crypto-currencies are enabled by blockchain technology
- Blockchain encompasses a wide set of concepts, digital technology, and **more uses than cryptocurrency!**

▪ A blockchain is

- 1. A chain of **digital blocks of information**, which could relate to anything (the amount of information stored within a block depends on the application)
- 2. Each block in the chain is **connected cryptographically** to the **preceding** block, forming a chain
- 3. To add a block, there must be **‘consensus’** among participants in the chain (different types of consensus mechanism may be employed)
 - 2. and 3. give a blockchain its **immutable property** i.e. it is /should be tamper-proof (almost impossible to change without consensus)
- 4. The chain is **updated dynamically** as each block is added and is visible in almost real time in multiple locations in a **distributed ledger**

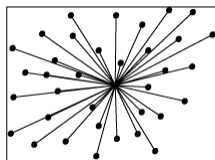
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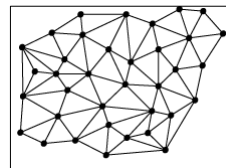
Where is the blockchain stored?

▪ Importantly, blockchain is a **distributed ledger technology**

- Note: a ledger is just the set of digital records captured on the blocks



Centralised ledger - owned/controlled by one participant in a network



Distributed ledger – potentially all participants in a network have visibility and access

▪ Different **types of blockchain**

- **Public /Open** – anyone can access/write to the blockchain
- **Private/Permissioned** – access and visibility is limited to participants and depends on the agreed governance mechanism
- + others (hybrid/consortia)
- Consensus mechanisms differ by blockchain type – cryptography and consensus are **more complex in public blockchains**

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Blockchain in the supply chain – why?

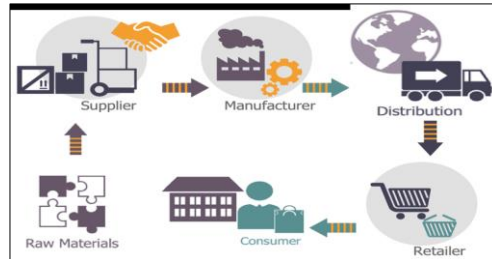
How do we track and trace today?

Different IT systems

- Raw material suppliers,
- Packaging, manufacturers,
- Logistics companies,
- Retailers

in **different locations**

- Where is the **digital record**?



Dispersed digital record
limited access, verifiability,
visibility, temporary



Single digital record
on
an immutable blockchain

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Blockchain in the supply chain – why?

- A block may contain information on processes, operations, transactions etc. Each block is time stamped and may contain geo-location information
- Such an immutable, verifiable digital record of supply chain transactions has many potential supply chain applications



- **Provenance** - where has this product come from?
- **Traceability** – where has it been?
- **Authenticity** – is this a genuine product?
- **Sustainability** – has this product been produced in a sustainable way?
- + many other claimed applications (e.g. **smart contracts**)



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Lenzing - A Blockchain Pilot Study

Ahmed, W. A., & MacCarthy, B. L. (2021).
Blockchain-enabled supply chain traceability in the
textile and apparel supply chain: A case study of
the fiber producer, Lenzing. Sustainability, 13(19),
10496.
<https://www.mdpi.com/2071-1050/13/19/10496>


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Lenzing Group Products Offering




1. TENCIL Fibers

- Lyocell fibers
- Mainly for Textile
- Use of REFIBRA technology – recycling cotton waste and own lyocell fibers.
- Partners: ASOS, Levi's, H&M, Guess, TED Baker, etc.




2. Eco Vero Fibers

- Viscose fibers.
- Certified renewable wood sources.
- 50% less emissions and water impact.
- Partners: J.Crew, MONSOON, ESPRIT, etc.



3. VEOCEL Fibers

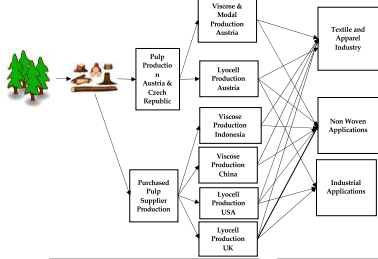
- Lyocell fibers.
- Mainly for nonwoven applications.
- Great water absorption and smoothness.
- Ideally used for sanitary and baby care products, wipes, facial sheets, etc.



4. LENZING Fibers

- Lyocell Fibers.
- Hi-Tech fibers for industry and agriculture solutions.
- Provides sustainable packaging solutions.
- Provides strong fibers ideal for industrial uniforms.

- A world leading manmade cellulose fiber producer.
- Lenzing fibers are made from wood.
- Three types of fibers: Viscose, Modal, and Lyocell.
- Three downstream applications.
- Highly sustainable manufacturing processes (i.e., use of Refibra technology that use 30% recycled cotton in fiber production).



The diagram illustrates the Lenzing supply chain. It starts with 'Pulp Production' (split into 'Pulp Production in Austria & Czech Republic' and 'Purchased Pulp Supplier Production') and 'Bio Refinery Products'. These feed into 'Viscose & Modal Production Austria', 'Lyocell Production Austria', 'Viscose Production Indonesia', 'Viscose Production China', 'Lyocell Production USA', and 'Lyocell Production UK'. These production stages then feed into 'Textile and Apparel Industry', 'Non Woven Applications', and 'Industrial Applications'. At the bottom, 'Machinery • Chemicals • Energy' is shown as a supporting input.

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JAGUAR LAND ROVER AUTOMOTIVE PLC
ANNUAL REPORT 2021/22

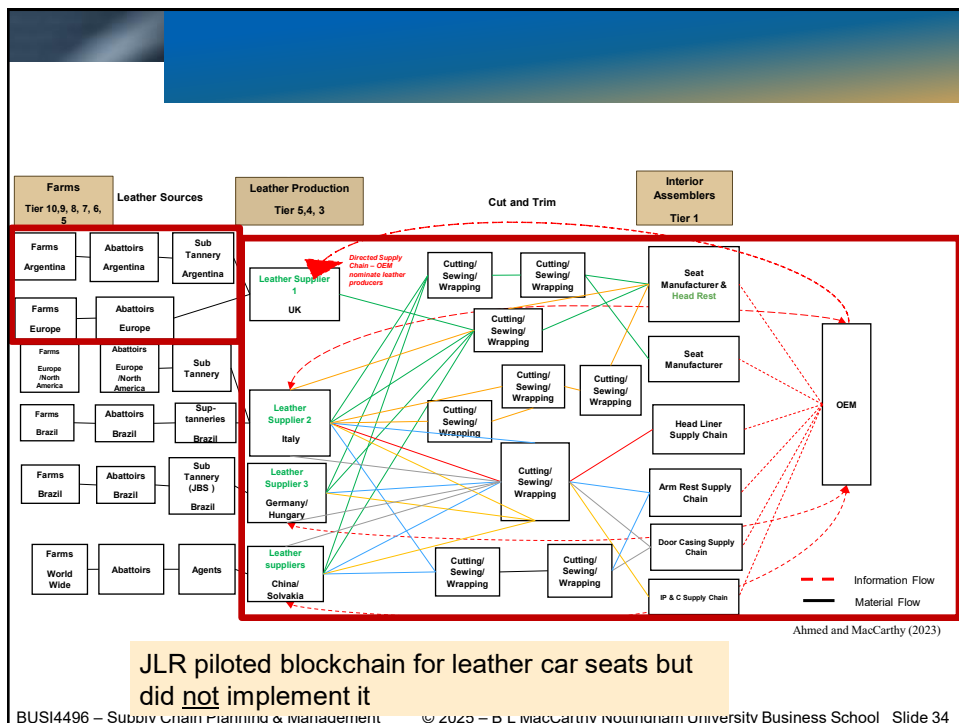


Automotive Leather Supply Chain




<https://media.jaguarlandrover.com/news/2021/10/jaguar-land-rover-trials-world-first-digital-supply-chain-leather-using-blockchain>

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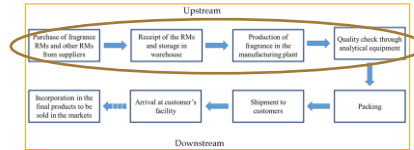
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<p>My Way Intense by Giorgio Armani</p> 	<ul style="list-style-type: none"> Plant-based alcohol distilled from French beets^{2,9} Made of consciously sourced ingredients⁴ Orange blossom from Egypt³ Tuberose from India^{2,9} Sandalwood from New Caledonia^{2,9} Vanilla is sourced from an NGO in Madagascar, which provides work and income for those in the community^{3,8} Use natural ingredients which are responsibly and sustainably sourced⁴ Vanilla from Madagascar is cultivated by local programs that support underprivileged communities based on Fair Trade principles^{3,5} Eco-conception and biodiversity protection⁹ Achieves carbon neutrality⁷ 	<ul style="list-style-type: none"> M+R+P SE+SS M+P M+P M+P M+P+SS+SM M+S M+P+SS+SM SE SE 	<p>(Armani, 2022, Wilkins, 2021)</p>
Product	Image	Claims	Reference

Should we believe these claims?

- **Big global sector - 50.8 billion USD** (Grandviewresearch.com, 2022)
- **Burgeoning market for sustainable, ethically produced fragrances**



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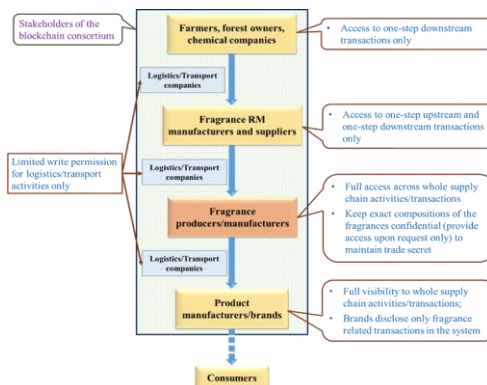
Smell the Perfume: Can Blockchain Guarantee the Provenance of Key Product Ingredients in the Fragrance Industry?

Claim Category

- Origin/Provenance (O)
- Authenticity (A)*
- Material (M)
- Quality (Q)
- Upcycling (U)
- Processing (P)
- Classified or Certified (C)
- <https://www.mdpi.com/2071-1050/16/14/6217>
- Traceable (T)
- Environmental Sustainability (SE)
- Social/Ethical Sustainability (SS)
- Economic Sustainability (SM)

Traceability and high degree of transparency

Type of Blockchain Network, Consortium membership, Permissions, access, and visibility, End consumer visibility



Very desirable to have traceability but very difficult to achieve blockchain solutions in practice!

There may be new solutions - developing Digital Product Passports

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Blockchain in the supply chain – challenges

- It is a **collaboration problem!**
- Blockchain may generate **more trust** across a supply network but
 - Most current applications use **private /permissioned blockchains**
 - **Governance issues** – who can access, who has visibility, who can add blocks, who should add block?
 - Will **all** supply chain **participants agree** to participate?
 - Do we **know or have access to all supply network participants**?
 - What level of **transaction granularity** is needed?
 - Is the **blockchain record reliable**?
 - Is it better than existing digital records?
- The **evidence is emerging ...**
- **It is hard to do!**

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Key Learning points 1

- **Supply chain management requires integration and coordination of the supply chain**
- **What happens when you don't collaborate?**
- **The Bullwhip Effect** occurs when supply chains are not integrated or coordinated
- **Supply Chain partnerships** are needed to agree how partners should work together
- **Many approaches to collaboration** but collaboration is difficult!
- Collaboration on **inventory management**
 - **Continuous Replenishment**
 - **Vendor Managed Inventory (VMI)**
- Collaboration on **planning, forecasting and replenishment (CPFR)**
 - care needed on what information is shared

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Key Learning Points 2

- In the future **Blockchain technology** may provide a means for effective collaboration based on **trust** but very difficult to do

Covered in the pre-recorded session

- **Performance measurement** in supply chain and operations planning and control is important
- It needs **process-focused metrics (e.g. utilisation)** and **customer-focused metrics (e.g. on-time delivery)** to ensure demand is met cost effectively
- **SCOR is an integrated** supply chain performance measurement **framework**
- **SCOR measures performance across** each of the key processes **PLAN, MAKE, SOURCE, DELIVER**