

Supply Chain Management

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MGM 660

Lecture 10





Sustainability and the Supply Chain & New trends in Supply Chains

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Course Agenda

Chapter

1. Define supply chain sustainability.
2. Explain the three pillars of sustainability.
3. Identify the benefits and challenges of sustainable supply chains.
4. Understand how sustainability affects procurement, manufacturing, logistics, and reverse logistics.
5. Analyze real-world company examples of sustainable supply chain practices.
6. What's trending right now in Supply chains
7. Major research themes in Supply-chain Academia & Practice

What is a Sustainable Supply Chain?

A sustainable supply chain is the management of material, information, and financial flows while considering:

- **Environmental protection**
- **Social responsibility**
- **Economic performance**

The objective is to create value throughout the supply chain while minimizing negative environmental and social impacts.

Improving sustainability performance may require accepting higher short-term costs to achieve long-term strategic benefits.

1. Sustainable Procurement

Focuses on purchasing from suppliers that meet environmental and social standards.

Examples:

- Selecting ISO 14001-certified suppliers
- Purchasing recyclable materials
- Choosing local suppliers to reduce transportation emissions
- Ethical sourcing

2. Sustainable Manufacturing

Objectives include:

- Reducing waste
- Improving energy efficiency
- Using renewable energy
- Water conservation
- Cleaner production technologies

Examples:

- Solar-powered factories
- Lean manufacturing
- Zero-waste initiatives

3. Sustainable Transportation

Strategies include:

- Route optimization
- Electric vehicles
- Alternative fuels
- Intermodal transportation
- Consolidated shipments

Benefits:

- Lower fuel costs
- Reduced carbon emissions
- Improved delivery efficiency

4. Sustainable Warehousing

Examples include:

- LED lighting
- Smart energy management
- Solar panels
- Green buildings
- Automated inventory systems

5. Sustainable Packaging

Objectives:

- Reduce packaging material
- Recyclable packaging
- Biodegradable materials
- Reusable containers

Benefits:

- Lower waste
- Lower transportation cost
- Better customer perception

6. Reverse Logistics

Activities include:

- Product returns
- Recycling
- Remanufacturing
- Refurbishment
- Proper disposal

Benefits:

- Recover product value
- Reduce landfill waste
- Improve sustainability

Role of Sustainability in a Supply Chain

- Focusing on sustainability allows a supply chain to better serve more conscious customers while often improving supply chain performance
- Customers have usually backed up words about the importance of sustainability without a willingness to pay more for sustainable products.
- Sustainable supply chain management can create competitive advantage while supporting environmental and social responsibility
- **Three pillars of sustainable development**
 - Economic sustainability
 - Environmental sustainability
 - Social sustainability
- **Factor categories**
 1. Reducing risk and improving the financial performance of the supply chain
 2. Community pressures and government mandates
 3. Attracting customers that value sustainability

Role of Sustainability in a Supply Chain

Environmental Sustainability

Examples:

- Carbon footprint reduction
- Renewable energy
- Water conservation
- Waste reduction
- Circular economy
- Green procurement

Social Sustainability

Includes:

- Safe working conditions
- Fair wages
- Human rights protection
- Supplier code of conduct
- Diversity and inclusion
- Community engagement

Economic Sustainability

Focuses on:

- Long-term profitability
- Operational efficiency
- Innovation
- Risk management
- Cost reduction
- Business continuity

Role of Sustainability in a Supply Chain

- In reality, actions in a supply chain improve both sustainability and supply chain surplus.
- Most effort expended in reducing risk
- Activity slow as actions may require upfront investment
- Barriers to increased focus on sustainability
 - **Insufficient return on investment**
 - **Customers' unwillingness to pay a premium for green products**
 - **Difficulty evaluating sustainability across a product life cycle**

Key Pillars of Sustainability

- Measuring performance along all three pillars may be required to evaluate the impact of sustainability-related efforts
- Companies that invest in sustainability may improve both profitability and brand reputation
- Sustainability initiatives often require collaboration across multiple supply chain partners.
- Sustainability should be integrated into every stage of the supply chain, from sourcing to product disposal.
- Two fundamental challenges for social and environmental pillars
 - **Scope of measurement**
 - **Absolute of relative measures**

Linear Economy

Take → Make → Use → Dispose

Circular Economy

Take → Make → Use → Reuse → Repair → Refurbish → Recycle

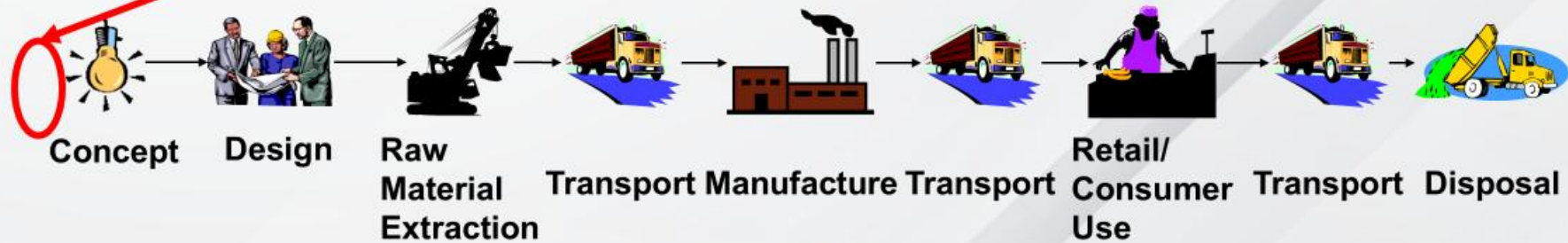
Benefits:

- Less waste
- Better resource utilization
- Lower environmental impact

The product life cycle is the basis of green supply chain management.

Supply Chain in the Environmental Life Cycle

Designing the supply chain concurrently with the product is a *supply chain management* best practice.



Typical Supply Chain Scope

Reverse Logistics



**Reverse logistics—
putting the supply chain
into reverse for all flows**

Material flows

- Product returns
- Repairs
- Remanufacture
- Recycling
- Recovery
- Disposal

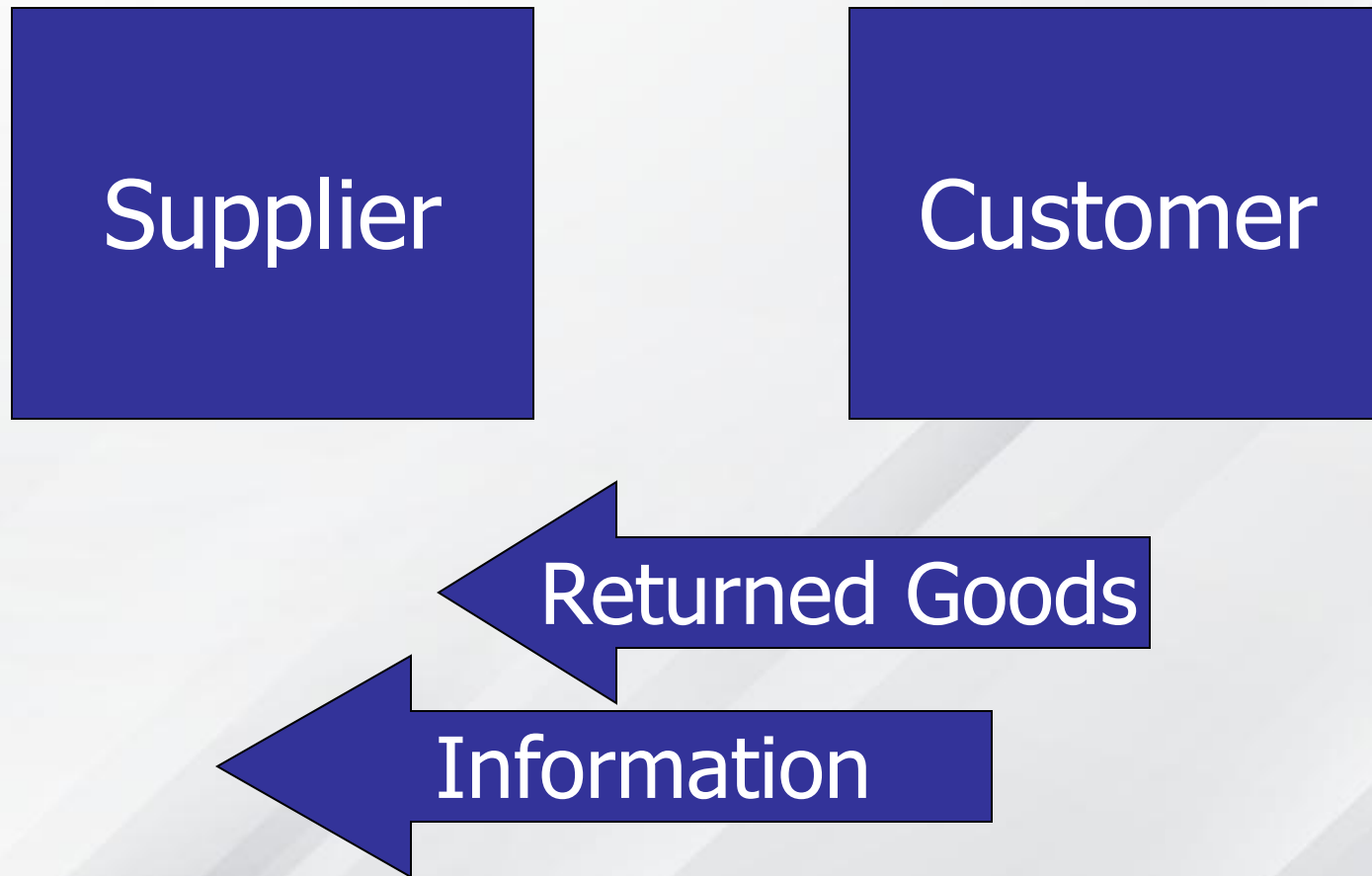
Payments

- Credits
- Cash refunds
- Rain checks
- Discounts
- Service contract fees

“A complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling.”

- Can represent major costs to a company
- Amount of goods returned
 - up to 50% in the publishing industry
 - 90% of automotive starter motors or alternators
- Companies are taking responsibility of the return of packaging materials
- **Reverse Logistics – Information**
- Goods are returned to supplier
- Information is also needed
 - reason / approval for the return
 - credit information

Reverse Logistics



- Green supply chain management includes environmental considerations throughout the product life cycle.
- Return and disposal of packaging materials
- Return and disposal of environmentally sensitive materials
 - **heavy metals**
 - **solvents**
- Use of reusable (returnable) packaging

Returned Goods

- Quality demands by customers
- Damage or defects
- Excessive inventories
- Seasonal inventories
- Out-of-date inventories
- Remanufacturing or refurbishment

Returned Goods - Disposition

- Returned to inventory
- Refurbished for resale
- Sold into alternate markets
- Disassembled to retrieve components
- Sorted for material recovery



Why have a reverse supply chain?

Aftermarket revenue



Sell recovered metals, etc., from returned products, containers.

Competitive edge



Woo consumers with promise of excellent customer service.

Pressure



Comply with “green” pressure from shareholders, consumers, regulators.

“Green” revenue



Sell into market for “organic,” “natural,” chemical-free, ecologically safe products.

Conscience



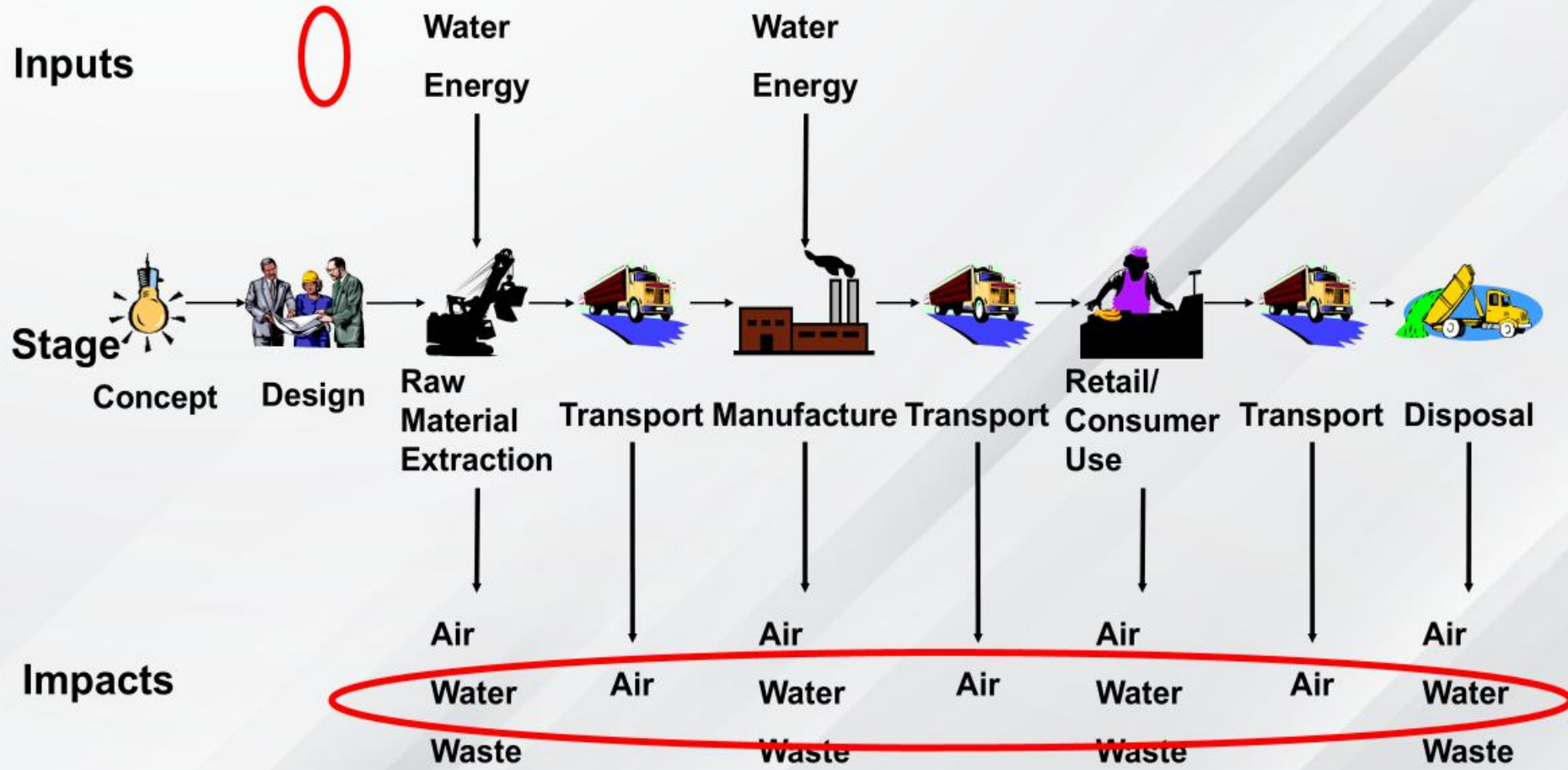
Do the right thing.

The reverse logistics hierarchy

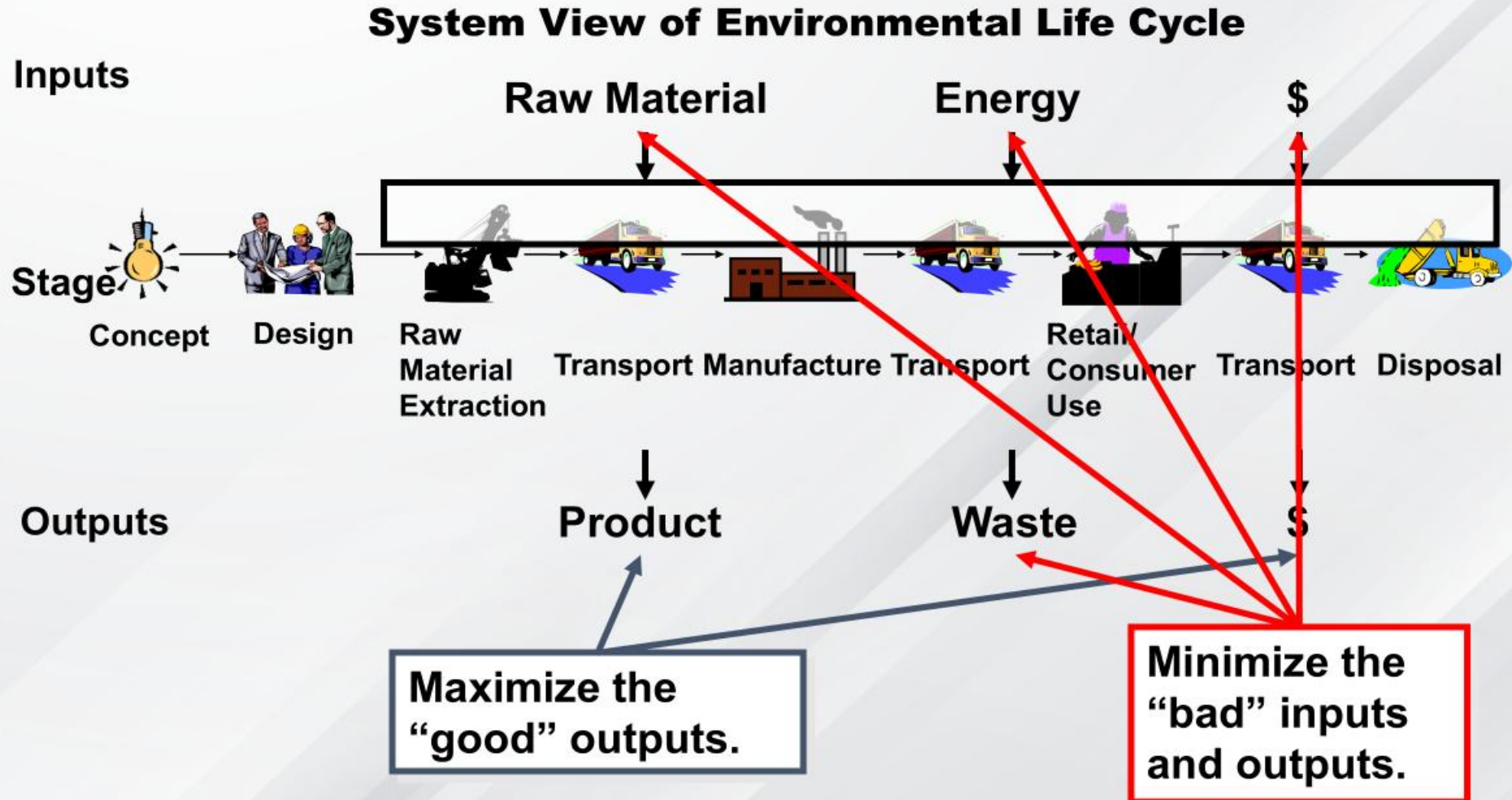


The environmental impacts of each LC stage are examined for reduction.

Environmental Life Cycle



Evaluating the supply chain as a system leads to life cycle optimization.



Supply chain design for reverse logistics

- **Reverse flows require their own systems.**
 - Information flows need worldwide data warehouse.
 - Cash flows (credits, etc.) need customer-centered approach.
 - Product flows need reverse forecasting, special collection locations, processing centers, and transportation.
- **Reverse revenues minus reverse expenses can bring profits.**
- **Life cycle design considers the 4 Rs in all phases of product life.**
 - Design for wise use of resources, reuse of old products.
 - Prepare for returns before introduction.
 - Develop systems to support continued use, upgrades in maturity.
 - Be prepared for end-of-life cycle, especially with dangerous goods.

The payoffs

- ▶ Lucrative customer service contracts
- ▶ Fewer, or no, costly returns
- ▶ Enhanced customer loyalty and reputation
- ▶ Revenues for materials in product returns
- ▶ More efficient products and logistical tactics
- ▶ New types of jobs
- ▶ More sustainable use of energy and resources
- ▶ Reduction of harmful emissions and pollutants
- ▶ Reduced need for landfills and incinerators

Drivers:

- *Need for regulatory compliance
- *Need to avoid environmental degradation
- *Need to compete

Barriers:

- *Incompatible corporate objectives
- *Short-term incentive system
- *Cultural resistance to change
- *Lack of top management support
- *Lack of supply chain strategic role

Enablers:

- *Linking sustainability to overall organization strategy
- *Making supply management a strategic activity
- *Having top management support
- *Having proactive rather than reactive approach to issues of sustainability
- *Having a long-term perspective

Sustainable supply management

Benefits:

- *Reduced costs over entire life cycle
- *Reduced overall organizational costs
- *Increased competitive advantage
- *Increased profits
- *Decreased damage to the environment
- *Increased innovation
- *Gain of new customer markets
- *Risk mitigation

Supply Chain Drivers

Supply chain drivers are classified into two categories:

A. Logistics Drivers

- Facilities
- Inventory
- Transportation

B. Cross-Functional Drivers

- Sourcing
- Information
- Pricing
- Match pillars with drivers
- **Measure environmental impact for each driver along each of the social and environmental categories**

Facilities

- Consumers of energy and water and emitters of waste and green- house gases
- Separate the improvement opportunities into those that generate positive cash flows and those that do not
- Facilities often offer the best opportunity to simultaneously improve the environmental and financial performances through innovation

Sustainable Practices

- Green building design (LEED-certified facilities)
- Solar panels and renewable energy
- LED lighting
- Smart energy management systems
- Water recycling systems
- Waste reduction programs
- Energy-efficient equipment

Inventory

- Most supply chains focus on raw materials, work in process, finished goods
- Inventory in a landfill
- Cost borne collectively by society
- Reduce harmful inventory, unlock unused value
- “Cradle to cradle” design

Sustainable Inventory Strategies

- Just-in-Time (JIT)
- Better demand forecasting
- AI-based inventory optimization
- Product life-cycle management
- Inventory sharing
- Reduced safety stock where appropriate

- Improve environmental performance through resource and emission reduction
- Product design can play a significant role

Sustainable Transportation Strategies

- Electric vehicles
- Alternative fuels
- Route optimization
- Shipment consolidation
- Intermodal transportation
- Local sourcing
- Autonomous delivery technologies

Sourcing

- Greatest social and environmental impact occurs in the extended supply chain
- Impact has grown with increased global sourcing
- Verifying and tracking supplier performance with regard to sustainability a major challenge

Sustainable Procurement

- Supplier environmental audits
- Ethical sourcing
- Local sourcing
- Fair labor practices
- Supplier sustainability scorecards
- Supplier collaboration

- One of the biggest challenges to improved supply chain sustainability
- Absence of standards for measurement and reporting means that some claims of environmental improvement are not verifiable

Sustainable Information Systems

- ERP systems
- IoT sensors
- AI analytics
- Blockchain
- Digital twins
- Carbon tracking software

- Differential pricing can improve the utilization of assets, leading to resource reduction
 - Delays the need for additional capacity
- Consumption visibility and differential pricing potentially lead to reduce resource consumption
- Biggest challenge is changing the customer's willingness to pay
- Government incentives can encourage customers and firms

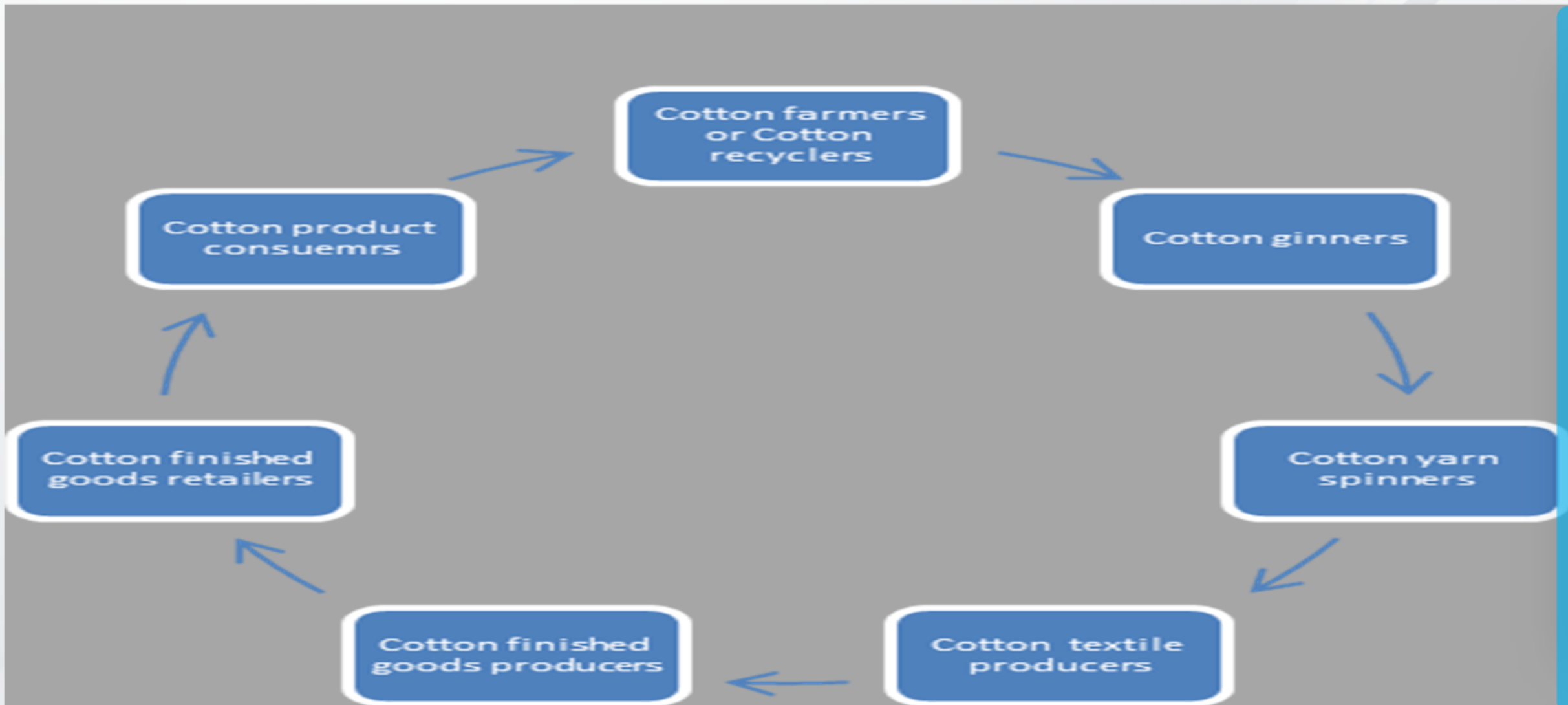
Sustainable Pricing Strategies

- Dynamic pricing
- Carbon pricing
- Discounts for eco-friendly products
- Deposit-refund systems
- Incentives for reusable packaging

Closed-Loop Supply Chains

- Improve sustainability by designing products that use fewer resources and can be recycled and remanufactured
- **Depends on**
 - The incentive to recycle or remanufacture
 - The cost to recycle or remanufacture
- Cannibalization of demand for new products
- Cost of recycling or remanufacturing has a significant impact on the process of recycling

Closed loop of typical cotton products' supply chain



Pricing of Sustainability

- Internalize the “monetary value” of the social or environmental cost
- Incorporate suitable prices for the social and environmental impacts of different actions
- Significant challenges to setting these prices

Pricing Emissions

- Firms will not put sufficient effort into reducing GHGs unless they are “forced” to reduce emissions or required to pay for the social cost of their emission
- **Two approaches**
 - Carbon tax
 - Cap-and-trade system

- **Evaluating pricing mechanisms**

- Cost of administration
- Price volatility
- Emission uncertainty
- New information uncertainty
- Industry competitiveness
- Wealth transfer to energy-exporting countries
- Revenue neutrality

- High initial investment
- Supplier resistance
- Lack of sustainability data
- Global supply chain complexity
- Measuring sustainability performance
- Balancing cost and environmental go

Key Sustainability Metrics (KPIs)

- Carbon emissions (CO₂)
- Energy consumption
- Water usage
- Waste generation
- Recycling rate
- Supplier sustainability score
- Percentage of renewable energy used
- On-time delivery with reduced emissions

1. Patagonia

- Uses recycled materials in clothing.
- Repairs and resells used garments through circular economy initiatives.
- Promotes responsible sourcing and environmental conservation.

2. Unilever

- Works with suppliers to reduce greenhouse gas emissions.
- Promotes sustainable agriculture.
- Reduces plastic packaging across many product lines.

3. IKEA

- Uses renewable energy.
- Sources wood from responsibly managed forests.
- Designs products for recycling and reuse.

4. DHL

- Invests in electric delivery vehicles.
- Optimizes transportation routes using digital technologies.
- Targets significant reductions in logistics-related emissions.

5. Apple

- Expands the use of recycled materials in devices.
- Uses renewable electricity in many operations.
- Encourages supplier adoption of clean energy.

Technology

Artificial Intelligence (AI)

Internet of Things (IoT)

Blockchain

Big Data Analytics

Robotics

Digital Twins

Sustainability Contribution

Forecasting, route optimization, demand planning

Energy monitoring, predictive maintenance

Traceability and ethical sourcing

Waste reduction and demand forecasting

Energy-efficient automation

Supply chain simulation and optimization

Summary

- Sustainability has become a strategic requirement rather than an optional initiative.
- Organizations that integrate environmental protection, social responsibility, and economic performance throughout procurement, production, logistics, warehousing, and reverse logistics can reduce costs, strengthen resilience, comply with regulations, enhance their reputation, and achieve long-term competitive advantage.
- Successful supply chains balance the needs of **People, Planet, and Profit** while creating value for customers and society.

1. Artificial Intelligence (AI) & Generative AI

- AI-powered demand forecasting
- Inventory optimization
- Supplier risk prediction
- AI procurement assistants
- Warehouse automation
- Generative AI for supply chain planning and reporting

Examples: Amazon, Walmart, Unilever

2. Supply Chain Resilience

- Multi-sourcing
- Nearshoring
- Regional manufacturing
- Business continuity planning
- Risk management

Drivers

- COVID-19 lessons
- Geopolitical conflicts
- Climate disruptions

3. Sustainability & Green Supply Chains

- Net-zero supply chains
- Carbon footprint reduction
- Circular economy
- Reverse logistics
- Green procurement
- ESG reporting

KPIs

- CO₂ emissions
- Energy consumption
- Waste reduction
- Water usage

4. Digital Supply Chains

- Digital transformation
- Cloud-based ERP
- Digital twins
- End-to-end visibility
- Real-time monitoring

Technologies

- IoT
- Cloud Computing
- AI
- Big Data

5. Supply Chain Visibility

- Real-time shipment tracking
- Inventory visibility
- Supplier visibility
- Control towers

Benefits

- Faster decisions
- Better customer service
- Reduced disruptions

6. Internet of Things (IoT)

Applications include:

- Smart warehouses
- Smart shelves
- Temperature monitoring
- Fleet tracking
- Predictive maintenance

7. Blockchain

- Applications:
- Product traceability
- Food safety
- Counterfeit prevention
- Smart contracts
- Supplier transparency

Industries:

Food

Pharmaceuticals

Luxury goods

8. Last-Mile Delivery Innovation

- Delivery lockers
- Electric vehicles
- Delivery drones
- Delivery robots
- Crowd shipping
- Route optimization

- **AI optimizes inventory management** . This is done by analyzing sales data, supply chain dynamics, and external variables to maintain ideal stock.
- **Demand forecasting**. AI-powered demand forecasting enables companies to predict future demand for products with high accuracy by analyzing a wide range of data sources.
- **Improved warehouse efficiency**. AI, specifically ML models, helps lay out warehouses more efficiently by being able to evaluate the quantity of materials
- **More-timely deliveries**. Manufacturers that assemble products via complex supply chains are especially dependent on timely and well-coordinated deliveries .
- **AI can help make supply chains more sustainable** by optimizing routes and reducing carbon emissions through smart logistics.

الموضوعات البحثية المقترحة

Sustainability, ESG, Circular Economy, and Carbon-Economics (“Carbonomics”)

Resilience & Risk Management under Uncertainty (Climate, Pandemic, Cybersecurity)

AI in warehousing and Logistics

Reshoring, Nearshoring & Geopolitical Risk / Resilience

Last-Mile & Logistics Innovation

Blockchain for Enhanced Transparency and Security in Supply Chain

Strategic sourcing and supplier management in the manufacturing industry

Global Supply Chain Integration

Digital Transformation in Supply Chain Management

Inventory Management and Optimization

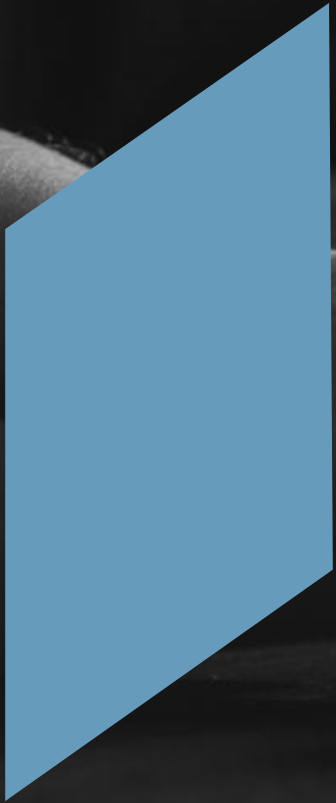
E-commerce and Supply Chain Logistics

Supply Chain Disruption and Resilience

Summary of Learning Objectives

1. Define supply chain sustainability.
2. Explain the three pillars of sustainability.
3. Identify the benefits and challenges of sustainable supply chains.
4. Understand how sustainability affects procurement, manufacturing, logistics, and reverse logistics.
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Thank You