MEV425
Supply Chain Management

Ingredients of success:
“Work hard, work right, work together!”
Lecture Organization

- Lecturing
- Group exercises
- Quizzes/Assignments/Tutorials
- Case discussion
- Case study presentations
### Grading Policy

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
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<tbody>
<tr>
<td>Assignment and Quiz</td>
<td>10%</td>
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<tr>
<td>Mini-project</td>
<td>10%</td>
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<tr>
<td>Test 1</td>
<td>15%</td>
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<td>Test 2</td>
<td>15%</td>
</tr>
<tr>
<td>End Exam</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Mini-project**
- Mini-project in supply chain
- Presentation on a relevant topic on supply chain


References

Module 1 - Part I
Introduction

- Why study Supply Chain Management?
- Operations Management
- Supply Chain Management
- Important trends
Why Study Operations and Supply Chain Management?
Three Basic Truths

I. Pervasiveness

II. Interdependence

III. Profitability and Survival
1. Pervasiveness

Every organization must make a product or provide a service that someone values............

Manufacturer.
Retailer.
Design firm.
University.
Health services.
2. Interdependence

Most organizations function as part of a larger supply chain.
Supply Chains

- Networks of manufacturers and service providers that work together to move goods from the raw material stage through to the end user
- Linked through physical, information, and monetary flows
3. Profitability and Survival

Organizations must carefully manage their operations and supply chains to prosper, and indeed, survive!
Operations Management

THE PLANNING, SCHEDULING, AND CONTROL OF THE ACTIVITIES THAT TRANSFORM INPUTS INTO FINISHED GOODS AND SERVICES
Operations Function

The collection of people, technology, and systems within a company ...

... that has primary responsibility ...

... for providing the organization’s products and/or services.
Viewing Operations as a Transformation Process

Inputs → Outputs

Manufacturing operations

- ✓ Materials
- ✓ People
- ✓ Equipment
- ✓ Intangible needs
- ✓ Information

Service operations

- ✓ Tangible goods
- ✓ Fulfilled requests
- ✓ Information
- ✓ Satisfied Customers
Manufacturing

• **Tangible** product

• Key decisions driven by physical characteristics of the product:
  
  o *How is the product made?*
  o *How do we store it?*
  o *How do we move it?*
  o *Etc.*
A round watermelon needs lot of room in a refrigerator and the usually round fruit often sits awkwardly on refrigerator shelves. Smart Japanese Farmers have forced their watermelons to grow into a square-shape by inserting the melons into square, tempered glass cases while the fruit is still growing on the vine.

“Cuboid Watermelon”
Services

- Intangible “Product” or Service

- Key decisions:
  - How much customer involvement?
  - How much customization?
Cross-Functional Linkages

Finance
- Budgeting
- Analysis
- Funds

MIS
- What IT solutions to make it all work together?

Human Resources
- Skills?
- Training?
- # of Employees?

Design
- Sustainability
- Quality
- Manufacturability

Operations and Supply Chain

Accounting
- Performance measurement systems
- Planning and control

Marketing
- What products?
- What volumes?
- Costs?
- Quality?
- Delivery?
Supply Chain Management

ACTIVE MANAGEMENT OF SUPPLY CHAIN ACTIVITIES AND RELATIONSHIPS TO MAXIMIZE CUSTOMER VALUE AND ACHIEVE A SUSTAINABLE COMPETITIVE ADVANTAGE
Module 1: Supply Chain Management

<table>
<thead>
<tr>
<th>Period</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancient Times</td>
<td>The first supply chain was the barter system</td>
</tr>
<tr>
<td>1904</td>
<td>Traces of outsourcing was seen when Charles S. Rolls became selling agent for cars made by F. Henry Royce</td>
</tr>
<tr>
<td>1960-1975</td>
<td>The essence of SCM was understood with the first phase characterized as an inventory ‘push’ era that focused primarily on physical distribution of finished goods</td>
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<tr>
<td>1975-1990</td>
<td>Companies began migrating from an inventory push to a customer pull channel</td>
</tr>
<tr>
<td>1980</td>
<td>Emergence of SCM</td>
</tr>
<tr>
<td>1985-</td>
<td>Walmart introduced the concept of Cross Docking</td>
</tr>
<tr>
<td>1996-</td>
<td>Internet revolutionized the distribution system of the business</td>
</tr>
<tr>
<td>1998-</td>
<td>Concept of e-commerce changed the definition of business</td>
</tr>
</tbody>
</table>
Understanding the Supply Chain

- Freight Transportation: $352, $455 Billion
- Inventory Expense: $221, $311 Billion
- Administrative Expense: $27, $31 Billion
- Logistics Related Activity: 11%, 10.5% of GNP

Source: Cass Logistics
### Traditional View: Logistics in the Manufacturing Firm

- **Profit**: 4%
- **Logistics Cost**: 21%
- **Marketing Cost**: 27%
- **Manufacturing Cost**: 48%

<table>
<thead>
<tr>
<th></th>
<th>Profit</th>
<th>Logistics Cost</th>
<th>Marketing Cost</th>
<th>Manufacturing Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4%</td>
<td>21%</td>
<td>27%</td>
<td>48%</td>
</tr>
</tbody>
</table>
Supply Chain Management: The Magnitude in the Traditional View

- Estimated that the grocery industry could save $30 billion (10% of operating cost) by using effective logistics and supply chain strategies
  - A typical box of cereal spends 104 days from factory to sale
  - A typical car spends 15 days from factory to dealership
- Laura Ashley turns its inventory 10 times a year, five times faster than 3 years ago
Supply Chain Management: The True Magnitude

- **Compaq** estimates it lost $0.5 billion to $1 billion in sales in 1995 because laptops were not available when and where needed.

- **P&G** estimates that it saved $65 million retail customers by collaboration resulting in a better match of supply and demand.

- **Boeing Aircraft**, one of America’s leading capital goods producers, was forced to announce write-downs of $2.6 billion in October 1997. The reason? “Raw material shortages, internal and supplier parts shortages...”. (Wall Street Journal, Oct. 23, 1997)
SOME ESTIMATES FOR INDIA

* Logistics Spend ... IN Rs. 2,40,000 crores (approx. US $ 50 Billion)
* Share of GDP .............. 12-13 %
* Major Elements are (Percentage of Total)
  * Transportation ........ 35
  * Inventories ............ 25
  * Packaging ............. 11
  * Handling & Warehousing ..... 9
  * Others & Losses ........ 14

Supply Chain Management: The True Magnitude
In 25 years, NDDB has enabled India to become the largest producer of milk by implementing a logistics and supply chain system that has eliminated several intermediaries, thereby leading to a much higher remunerative price (yield) for producers and lower price for consumers.

As described in the FORBES magazine, the Dabbawalas of Mumbai has achieved an extremely high level of reliability and precision (SIX SIGMA level in QA) in delivering to their customers the products earmarked for them.
Supply Chain: The Potential

- Dell Computer has outperformed the competition in terms of shareholder value growth over the eight years period, 1988-1996, by over 3,000% using
  - Direct business model
  - BTO (Build-to-Order) strategy.
In 10 years, Wal-Mart transformed itself by changing its logistics system. It has the highest sales per square foot, inventory turnover and operating profit of any discount retailer.
Outline

- What is a Supply Chain?
- Decision Phases in a Supply Chain
- Process View of a Supply Chain
- The Importance of Supply Chain Flows
- Examples of Supply Chains
Several hundred years ago, Napoleon made the remark, “An army marches on its stomach.”

Unless the soldiers are fed, the army cannot move.

Term “supply chain management” arose in the late 1980s and came into widespread use in 1990s.

Prior – ‘Logistics’ and ‘operations management’
Some Definitions

Supply Chain Management encompasses every effort involved in producing and delivering a final product or service, from the supplier’s supplier to the customer’s customer.

Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer.

The Supply Chain Council, U.S.A.
Supply Chain Management deals with the management of materials, information, and financial flows in a network consisting of suppliers, manufacturers, distributors and customers.

Stanford Supply Chain Forum

Logistics involves “managing the flow of items, information, cash and ideas through the coordination of supply chain processes and through the strategic addition of place, period and pattern values.

MIT Center for Transportation and Logistics
Supply Chain Management is primarily concerned with the efficient integration of suppliers, factories, warehouses and stores so that merchandise is produced and distributed in the right quantities, to the right locations and at the right time, and so as to minimize total system cost subject to satisfying service requirements.

Simchi-Levi

Call it distribution or logistics or supply chain management. By whatever name, it is the sinuous, gritty, and cumbersome process by which companies move, materials, parts, and products to customers.

Fortune (1994)
What is a Supply Chain?

- All stages involved, directly or indirectly, in fulfilling a customer request
- Includes manufacturers, suppliers, transporters, warehouses, retailers, and customers
- Within each company, the supply chain includes all functions involved in fulfilling a customer request (product development, marketing, operations, distribution, finance, customer service)
A picture is better than 1000 words!
How many words would be better than 3 pictures?

- A supply chain consists of

  
  
  Supplier  Manufacturer  Distributor  Retailer  Customer

  
  
  Upstream  Downstream

- Aims to Match Supply and Demand, profitably for products and services

- Achieves

  
  The right Product + The right Price + The right Store + The right Quantity + The right Customer + The right Time = Higher Profits
Example of a Supply Chain?

Customer wants detergent and goes to Supermarket

P&G or other manufacturer → Third party DC → Supermarket

Plastic Producer

Tenneco Packaging

Chemical manufacturer (e.g. Oil Company)

Paper Manufacturer

Timber Industry
What is a Supply Chain?

- CUSTOMER is an integral part of any supply chain
- Includes movement of products from suppliers to manufacturers to distributors, but also includes movement of information, funds, and products in both directions
- Probably more accurate to use the term “supply network” or “supply web”
- All stages may not be present in all supply chains (e.g., no retailer or distributor for Dell computer)
The Supply Chain – Another View

Plan → Source → Make → Deliver → Buy

 Suppliers

Manufacturers

Warehouses & Distribution Centers

Customers

Material Costs → Transportation Costs → Manufacturing Costs → Transportation Costs

Inventory Costs

Transportation Costs
What is Supply Chain Management (SCM)?

- A set of approaches used to efficiently integrate
  - Suppliers
  - Manufacturers
  - Warehouses
  - Distribution centers
- So that the product is produced and distributed
  - In the right quantities
  - To the right locations
  - And at the right time
- System-wide costs are minimized and
- Service level requirements are satisfied
Supply chain flows

Material flow

Information flow

Fund flow

Sourcing → Inbound storage/Transportation → Operations → Outbound storage/Transportation → Consumer distribution

Vendors → Customers
Material Flows

Upstream

Second Tier Supplier
Alcoa

First Tier Supplier
Ball Corp

Anheuser-Busch

Downstream

Distributor
M&M

Retailer
Meijer

Final customers

Transportation companies
Dynamics of Material Flow

Supplier → Plant → Warehouse → Logistics → Retailer
Supply Chain Planning Processes

Material Requirement Planning

Component Requirement

Production Plan

Demand Forecasting

Demand Planning

Supplier ➔ Plant ➔ Warehouse ➔ Logistics ➔ Retailer

Order Management
Supply Chain:
- A sequence of activities
- Organizations involved in producing
- Delivering a good or service
### A Supply Chain for Bread

<table>
<thead>
<tr>
<th>Stage of Production</th>
<th>Value Added</th>
<th>Value of Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer produces and harvests wheat</td>
<td>2.33</td>
<td>2.33</td>
</tr>
<tr>
<td>Wheat transported to mill</td>
<td>1.24</td>
<td>3.57</td>
</tr>
<tr>
<td>Mill produces flour</td>
<td>2.33</td>
<td>5.90</td>
</tr>
<tr>
<td>Flour transported to baker</td>
<td>1.25</td>
<td>7.15</td>
</tr>
<tr>
<td>Baker produces bread</td>
<td>8.35</td>
<td>15.50</td>
</tr>
<tr>
<td>Bread transported to grocery store</td>
<td>1.25</td>
<td>16.75</td>
</tr>
<tr>
<td>Grocery store displays and sells bread</td>
<td>3.25</td>
<td>20.00</td>
</tr>
<tr>
<td><strong>Total Value-Added</strong></td>
<td><strong>20.00</strong></td>
<td></td>
</tr>
</tbody>
</table>
The Objective of a Supply Chain

- Maximize overall value created
- Supply chain value: difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer’s request
- Value is correlated to supply chain profitability (difference between revenue generated from the customer and the overall cost across the supply chain)
The Objective of a Supply Chain

- Example: Dell receives 30000/- from a customer for a computer (revenue)
- Supply chain incurs costs (information, storage, transportation, components, assembly, etc.)
- Difference between 30000/- and the sum of all of these costs is the supply chain profit
- Supply chain profitability is total profit to be shared across all stages of the supply chain
- Supply chain success should be measured by total supply chain profitability, not profits at an individual stage
The Objective of a Supply Chain

- Sources of supply chain revenue: the customer
- Sources of supply chain cost: flows of information, products, or funds between stages of the supply chain
- *Supply chain management is the management of flows between and among supply chain stages to maximize total supply chain profitability*
Concept of supply chain could be thought of as a loop and ends with the customer.

Customer could be an internal customer or an external customer.
Process View of a Supply Chain

• Cycle view: processes in a supply chain are divided into a series of cycles, each performed at the interfaces between two successive supply chain stages

• Push/pull view: processes in a supply chain are divided into two categories depending on whether they are executed in response to a customer order (pull) or in anticipation of a customer order (push)
Cycle View of Supply Chains

Customer Order Cycle

Replenishment Cycle

Manufacturing Cycle

Procurement Cycle

Customer

Retailer

Distributor

Manufacturer

Supplier
Cycle View of a Supply Chain

- Each cycle occurs at the interface between two successive stages
- Customer order cycle (customer-retailer)
- Replenishment cycle (retailer-distributor)
- Manufacturing cycle (distributor-manufacturer)
- Procurement cycle (manufacturer-supplier)
- Cycle view clearly defines processes involved and the owners of each process. Specifies the roles and responsibilities of each member and the desired outcome of each process.
Supply chain processes fall into one of two categories depending on the timing of their execution relative to customer demand:

- **Pull**: execution is initiated in response to a customer order (reactive)
- **Push**: execution is initiated in anticipation of customer orders (speculative)
- Push/pull boundary separates push processes from pull processes
Push/Pull View of Supply Chains

Procurement, Manufacturing and Replenishment cycles

PUSH PROCESSES

Customer Order Arrives

PULL PROCESSES

Customer Order Cycle
A push-based SCM takes longer to react to the changing market place.

In a push-based supply chain, production decisions are usually based on long-term forecasts.

In push-based strategies, SCM experience increased transportation costs, high inventory levels and high manufacturing costs.

In a pull-based supply chain, manufacturing is demand driven so that it is coordinated with actual external customer demand rather than a forecast.

Lead-time reduction occurs as the variabilities are better monitored in pull-based SCM.

Pull-based systems are often difficult to implement when lead times are so long that it is impractical to react to demand information.
Supply Chain Integration – Push Strategies

- Classical manufacturing supply chain strategy
- Manufacturing forecasts are long-range
  - Orders from retailers’ warehouses
- Longer response time to react to marketplace changes
  - Unable to meet changing demand patterns
  - Supply chain inventory becomes obsolete as demand for certain products disappears
- Increased variability (Bullwhip effect) leading to:
  - Large inventory safety stocks
  - Larger and more variably sized production batches
  - Unacceptable service levels
  - Inventory obsolescence
- Inefficient use of production facilities (factories)
  - How is demand determined? Peak? Average?
  - How is transportation capacity determined?
- Examples: Auto industry, large appliances, others?
Supply Chain Integration – Pull Strategies

- Production and distribution are demand-driven
  - Coordinated with true customer demand
- None or little inventory held
  - Only in response to specific orders
- Fast information flow mechanisms
  - POS data
- Decreased lead times
- Decreased retailer inventory
- Decreased variability in the supply chain and especially at manufacturers
- Decreased manufacturer inventory
- More efficient use of resources
- More difficult to take advantage of scale opportunities
- Examples: Dell, Amazon
Push/Pull View of Supply Chain Processes

- Useful in considering strategic decisions relating to supply chain design – more global view of how supply chain processes relate to customer orders
- The relative proportion of push and pull processes can have an impact on supply chain performance
Supply Chain Integration – Push/Pull Strategies

- Hybrid of “push” and “pull” strategies to overcome disadvantages of each
- Early stages of product assembly are done in a “push” manner
  - Partial assembly of product based on aggregate demand forecasts (which are more accurate than individual product demand forecasts)
  - Uncertainty is reduced so safety stock inventory is lower
- Final product assembly is done based on customer demand for specific product configurations
- Supply chain timeline determines “push-pull boundary”
Choosing Between Push/Pull Strategies

Where do the following industries fit in this model:

- Automobile?
- Aircraft?
- Fashion?
- Petroleum refining?
- Pharmaceuticals?
- Biotechnology?
- Medical Devices?

Industries where:

- Customization is High
- Demand is uncertain
- Scale economies are Low

**Computer equipment**

Industries where:

- Demand is uncertain
- Scale economies are High
- Low economies of scale

**Furniture**

Industries where:

- Uncertainty is low
- Low economies of scale
- Push-pull supply chain

**Books, CD’s**

Industries where:

- Standard processes are the norm
- Demand is stable
- Scale economies are High

**Grocery, Beverages**

Source: Simchi-Levi
### Characteristics of Push, Pull and Push/Pull Strategies

<table>
<thead>
<tr>
<th></th>
<th>PUSH</th>
<th>PULL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Minimize Cost</td>
<td>Maximize Service Level</td>
</tr>
<tr>
<td><strong>Complexity</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Resource Allocation</td>
<td>Responsiveness</td>
</tr>
<tr>
<td><strong>Lead Time</strong></td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td><strong>Processes</strong></td>
<td>Supply Chain Planning</td>
<td>Order Fulfillment</td>
</tr>
</tbody>
</table>

Source: Simchi-Levi
Supply Chain Macro Processes in a Firm

Supply chain processes discussed in the two views can be classified into:

- Customer Relationship Management (CRM) - interface between the firm and its customers
- Internal Supply Chain Management (ISCM) – internal to the firm
- Supplier Relationship Management (SRM) - interface between the firm and its suppliers
Integration among the above three macro processes is critical for effective and successful supply chain management.
Decision Phases of a Supply Chain

- Supply chain strategy or design
- Supply chain planning
- Supply chain operation
Supply Chain Strategy or Design

- Decisions about the structure of the supply chain and what processes each stage will perform
- Strategic supply chain decisions
  - Locations and capacities of facilities
  - Products to be made or stored at various locations
  - Modes of transportation
  - Information systems
- Supply chain design must support strategic objectives
- Supply chain design decisions are long-term and expensive to reverse – must take into account market uncertainty
Supply Chain Planning

• Planning decisions:
  ○ Which markets will be supplied from which locations
  ○ Planned buildup of inventories
  ○ Subcontracting, backup locations
  ○ Inventory policies
  ○ Timing and size of market promotions

• Must consider in planning decisions demand uncertainty, exchange rates, competition over the time horizon
Supply Chain Operation

- Time horizon is weekly or daily
- Decisions regarding individual customer orders
- Supply chain configuration is fixed and operating policies are determined
- Goal is to implement the operating policies as effectively as possible
- Allocate orders to inventory or production, set order due dates, generate pick lists at a warehouse, allocate an order to a particular shipment, set delivery schedules, place replenishment orders
- Much less uncertainty (short time horizon)
# Supply Chain Decisions

<table>
<thead>
<tr>
<th>Procurement Policy</th>
<th>Manufacturing Policy</th>
<th>Distribution Policy</th>
<th>Logistics</th>
</tr>
</thead>
</table>
| • Supplier Selection  
  • Allocation of Suppliers to the Plants |
| • Location, Number, Capacity of Plants  
  • What Products to Produce  
  • Which Plants to Produce them |
| • Warehouse Allocation  
  • Inventory Decisions  
  • Manufacturing Policy |
| • Customer Allocation  
  • Distribution Policy |
| • Production Schedule  
  • Scheduling on Machines  
  • Workload Balancing |
| • Finished Goods Inventory |
| • Mode of Shipment  
  • Port Selection |
| • Vehicle Routing  
  • Fleet Size |
| • Vehicle Routing  
  • Vehicle Routing |