

1. Supply Chain Management & Logistics

1.1. Classical Logistics

1.1.1. Logistics as “organization of a complex operation”	<empty citation>
1.1.2. Logistics in Manufacturing	<empty citation>
1.1.3. Logistics in Services	<empty citation>

1.2. Supply Chain Management

1.2.1. What is a Supply Chain?	<empty citation>
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1.2.2. Supply Networks

In a manufacturing context, a supply chain can be seen as a network of suppliers, manufacturers, distributors, and retailers.

1.2.3. SCM vs. Logistics	<empty citation>
1.2.4. SCM Cycles	<empty citation>
1.2.5. SCM Processes	<empty citation>
1.2.6. SCOR Model	<empty citation>
1.2.7. Supply Chains as Systems	<empty citation>

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2.1. Flows

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2.2. Capacity

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2.2.2. Matching Supply with Demand	<empty citation>

3. Push-Pull Systems & Segmentation

3.1. Push-Pull Systems

3.1.1. Push and Pull Processes	<empty citation>
3.1.2. Product-Process Matrix	<empty citation>

3.2. Postponement & Mass Customization

3.2.1. Customer Order Decoupling Point	<empty citation>
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3.3. Product Segmentation

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3.3.2. Power “Law”	<empty citation>
3.3.3. ABC Analysis	<empty citation>
3.3.4. Multicriteria ABC Analysis	<empty citation>
3.3.5. AI/ML techniques for Segmentation	<empty citation>

3.4. Supply Chain Segmentation

3.4.1. Supply Chain Portfolios	<empty citation>
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4. Accounting POV for Inventory

4.1. Capital and Financial Statements

4.1.1. Sources of capital	1,2
Management seeks capital to finance operations from two main sources:	
Shareholders: Individuals or entities that purchase and hold shares of a company's stock, thereby owning a portion of the company's equity. They expect (and are entitled to receive) returns through investment appreciation and/or dividends, and also have the right to vote on certain company decisions. Unlike debtholders, shareholders have an ownership stake in the company, which carries both potential financial rewards and risks, as their investment value can fluctuate with the company's performance.	
Debtholders: Individuals or entities that lend capital to a company, usually in the form of loans or bonds, with the expectation of being repaid the principal amount along with interest over time. Unlike shareholders, debtholders do not obtain ownership stakes in the company, but hold a financial claim that is prioritized in the event of liquidation.	
The blended result of these contributions is called the capital structure .	

4.1.2. Flow of capital

4.1.3. Fundamental Business Activities	1,2
Operating Activities: → Form the core of a business through the management of operating assets for the production and/or sale of goods and services. → Encompass everyday functions to maintain business continuity. → Ideally, these activities ensure smooth operations for profit generation.	
Investing Activities: → Acquisition, replacement, and disposition of operating assets like inventory, buildings, and equipment. → Investments in intangible assets like know-how or Research and Development. → Investments in digital assets such as platforms and software. → Full or partial acquisition of other companies. → Planning and control of cash inflows to ensure rational and timely, opportune amounts.	
Financial Activities: → Focused on capital management, raising funds from shareholders and/or debtholders. → Selling financial assets or securities such as shares of stock and bonds. → Managing debt and dividend payments, or engaging in stock buybacks. → Evaluating various debt and equity financing options, designing a sound capital structure.	

4.1.4. The Balance Sheet: A Statement of Financial Position

1,2

Provides a snapshot of a company's financial position at a specific point in time, often at the end of a fiscal year, showcasing assets, liabilities, and shareholders' equity.

ASSETS Current Assets Cash: Petty cash, Bank accounts Short-term investments: Stocks, Bonds Accounts receivable: Credit sales Short-term notes receivable Prepaid expenses Inventory: Merchandise inventory, Supplies	LIABILITIES Current Liabilities Accounts payable Wages payable Interest payable Short-term notes payable Income taxes payable Current maturities of long term debts Deferred revenues
Fixed / Non-current / Long-term Assets Long-term investments Property, Plant, Equipment - Depreciation Intangible assets - Amortization Goodwill	Long-term Liabilities Long-term notes payable Bonds payable Mortgage Payable
SHAREHOLDER'S EQUITY Contributed capital Retained earnings	

The amount of highly liquid assets indicates ability to meet debt payments as they come due.

4.1.5. Elements of the Income Statement	1
Revenues indicate inflow of assets or reduction in liabilities, primarily from sales of inventories or services.	
COGS or Cost of Sales reflects the original cost of inventory sold, either its purchase price or its manufacturing cost. By subtracting this from Revenues, we arrive at the Gross Margin .	
R&D Expenses or Research & Development Expenses cover costs like product innovation or supply chain optimizations. Whereas SGA Expenses or Selling, General, and Administrative expenses, encompass costs that aren't directly tied to producing an item. This includes expenses such as salaries, rent, utilities, marketing, distribution costs, customer service as well as administrative costs like office supplies, legal fees, etc.	
By subtracting the aforementioned expenses, we derive EBITDA , which stands for Earnings Before Interest, Taxes, Depreciation, and Amortization. Further adjustments, primarily subtracting depreciation and amortization from EBITDA, yield the Operating Income , also known as EBIT (Earnings Before Interest and Taxes).	
Other revenues (or expenses) represent minor cash inflows or outflows not related to core operations. After accounting for these, we determine the Net Income , also referred to as Profit .	

4.1.6. The Income Statement Visualized

1,2

Let's examine a scenario where better demand-supply alignment results in a 5% sales increase, while also fairly accounting for a rise in costs and expenses.

Revenue	+2,000	+2,100
COGS or Cost of Sales	-1,200	-1,200
Gross Margin	800	900
R&D Expenses	-100	-110
SGA Expenses	-300	-330
EBITDA	400	460
Depreciation, Amortization	-160	-176
Operating Income or EBIT	240	284
Interests	-20	-24
Taxes	-60	-71
Other Revenues	+16	+16
Net Income	176	205

4.1.7. Profitable operations as a source of capital

1

Retained earnings represent the cumulative profits a company has generated and chosen to reinvest in the business rather than distribute as dividends. They don't pinpoint a specific tangible asset or cash pool. Instead, they indicate the portion of the assets listed on the balance sheet that stems from profitable operations.

These earnings highlight the capital sourced directly from profitable operations, distinguishing it from capital derived from borrowings or owner contributions.

4.2. Accounting for Inventory

4.2.1. Accounting categories of Inventory	1,3
Inventory plays a central role in accounting, reflecting a company's financial well-being and operational stance. It represents a major portion of a firm's assets, with its management directly affecting profitability and liquidity. Therefore, precise record-keeping is required to offer stakeholders a concise financial perspective crucial for investment decisions.	
Shifting our lens to manufacturing, we can delineate these specific inventory categories:	
→ Raw Materials: Fundamental inputs of a manufacturing process → Work in Progress (WIP): Inventory undergoing transformation from raw materials to final products. → Components: Individual parts, sourced or produced, essential for final product assembly. → Finished Goods: Fully processed products ready for sale.	
In a broader operational context, beyond pure manufacturing, we also consider:	
→ Merchandise Inventory: Ready-to-sell products acquired for resale without additional modification. → Supplies: Operational items not for sale, such as office materials. → MRO Items: Resources for maintenance, repair, and operations, distinct from final product materials.	

4.2.2. The Inventory Accounting Flow/Cycle

1

4.2.3. Capitalization of Inventory Costs & Units to include	1
Inventories are acquired at a cost and don't generate revenues until they're sold; thus, their cost is capitalized. Per the matching principle, the sale revenue is matched with the inventory's cost at the time of sale. To determine the capitalized cost, first identify the number of inventory items, then assign a cost to each item.	
General Rule: Items intended for manufacturing, sale, or consumption should be included in a company's inventory only if the company has full ownership of them, meaning that it bears all associated risks and benefits. Usually, ownership implies possession of the items, and in such cases, the units to be included in the inventory can be straightforwardly counted.	
However, there are situations where ownership doesn't necessarily mean direct possession. Two of these notable exceptions are: Consignments and Goods in Transit.	

4.2.4. Consignments

1

In a consignment arrangement, the *consignor* transfers inventory to a *consignee*, such as a retailer, who physically holds and sells the items. While the consignor retains full ownership, the consignee, after selling, keeps a service fee and remits the rest of the proceeds to the consignor.

Inventory should only be disclosed in the consignor's balance sheet.

4.2.5. Goods in Transit	1
Theoretically, both a seller and a buyer should record a transaction simultaneously. However, in practice, most sales are recorded when goods are shipped, while purchases are typically recorded upon receipt of the goods. This method is generally acceptable, unless there are <i>goods in transit</i> at the end of an accounting period.	
To properly account for such transactions, it's essential to determine the ownership of the goods while they are in transit. Freight shipping terms like FOB (free on board) serve this purpose. This term is commonly used in domestic shipping within the U.S., and should not be confused with the FOB term from the International Commercial Terms, INCOTERMS © 2020.	
<div>Both a sale and a purchase should be recorded</div> <div>FOB shipping point: Seller shipment Buyer</div> <div>End of the accounting period</div> <div>FOB destination: Seller shipment Buyer</div> <div>Neither a sale nor a purchase should be recorded</div>	
FOB shipping point: The seller is responsible for the goods only to the point from which they are shipped. FOB destination: The seller is responsible for the goods all the way to their destination.	

5.4.2. EOQ formula derivation

Since demand is deterministic, we can get rid of the Stockout Cost concept for now. So,

$$TRC(Q) = c_t \frac{D}{Q} + c_e \frac{Q}{2}$$

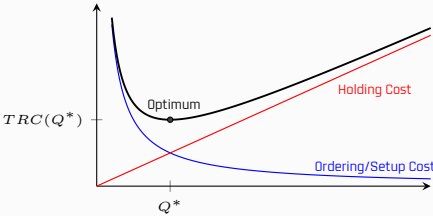
From the first-order optimal condition (first derivative equals zero), we have

$$0 = \frac{d}{dQ} \left(\frac{c_t D}{Q} \right) + \frac{d}{dQ} \left(\frac{c_e Q}{2} \right)$$

$$0 = -\frac{c_t D}{Q^2} + \frac{c_e}{2}$$

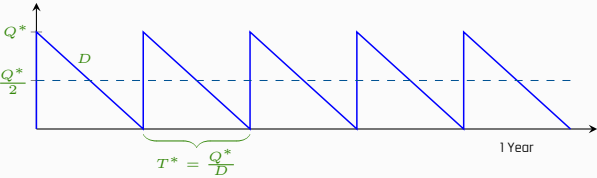
$$Q^* = \sqrt{\frac{2c_t D}{c_e}}$$

The EOQ or Q^* gives the minimum TRC under deterministic conditions:



5.4.3. EOQ Sawtooth Plot

The optimal policy becomes ordering Q^* units of inventory every T^* units of time.



Notice that the total consumption of the last order may take place after the 1 year (unit time) period.

5.4.4. Sensitivity Analysis for the EOQ model

Resaltar que, pese a que algunos parametros se asumen alegremente como determinísticos, el modelo es lo suficientemente robusto como para compensar variaciones en los mismos (e.g. demanda, costos, etc.) Usar los 5 libros en ...Análisis y logística de la producción + otros complementos

5.4.5. Powers of Two Policies

5.5. EOQ Extensions

5.5.1. Lead Time > 0

5.5.2. Discounts: All units

5.5.3. Discounts: Incremental

5.5.4. Discounts: One-time

5.5.5. Backorders

5.5.6. EPQ: Economic Production Quantity

5.5.7. Perishability

5.5.8. Trade Credit

6. Forecasting I

6.1. Demand Planning

6.1.1. Demand Planning

6.1.2. Demand Forecasting

6.2. Data Collection

6.2.1. Obtaining data

6.2.2. Aggregated data, Aggregated forecasts

6.3. Time Series

6.3.1. Time Series Components

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6.5.1. Simple Exponential Smoothing

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7.2.1. Intermittent demand patterns and examples

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7.2.3. Croston's Method

7.3. Regression & Causal Analysis

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7.3.2. Correlation and Causation

7.3.3. Simple Linear Regression

7.3.4. Multiple Linear Regression

7.4. Product Development, Marketing & Forecasting

7.4.1. New Products Introduction

7.4.2. Forecasting techniques & Product Life Cycle

7.5. AI/ML techniques for Forecasting

7.5.1. Clustering

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8.3.6. Critical Ratio

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8.4. The Newsvendor Problem

8.4.1. Newsvendor Problem: Introduction

NFL Jersey Problem in the MicroMasters

8.4.2. Unit Normal Loss Function

8.4.3. Newsvendor Problem: Solution

8.5. The Newsvendor Problem Extensions

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9. Inventory III: Multiple Period Inventory Models

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9.1.2. Base Stock Model

9.2. Continuous Review Models

9.2.1. (s, Q) model

9.2.2. (s, S) model

9.3. Safety Stock: Service Cost and Metrics

9.3.1. Cycle Service Level

9.3.2. Cost per Stockout Event

9.3.3. Item Fill Rate

9.3.4. Cost per Item Short

9.3.5. Inputted and Implied Metrics

9.4. Periodic Review Models

9.4.1. (R, S) model

9.4.2. (...) model

10. Inventory IV: Multiple Dimension Models

10.1. Multiple Items

10.1.1. Grouping

10.1.2. Grouping: Powers of Two

10.1.3. Grouping: Exchange Curves

10.2. Multiple Locations

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10.3. Multiple Classes

10.3.1. Segmentation Revisited	<empty citation>
- Fast moving items	
- Slow moving items	
...	

10.3.2. A Items	<empty citation>
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10.3.3. B Items	<empty citation>
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10.4. Multiple Echelons

10.4.1. Multiple Echelons	<empty citation>
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11. Transportation I: Freight Transportation

11.1. Freight Transportation

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- Pallets	
- Containers	
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11.2. Transportation Networks

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11.3. Transportation & Inventory

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11.3.4. Random Sum of Random Variables	<empty citation>
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12. Transportation II: Analysis

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12.1.4. Vehicle Routing	<empty citation>
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12.2. Transportation Economies

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12.4. Transportation & Routing Problems

12.4.1. 1 : 1	<empty citation>
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12.4.2. 1 : ∞	<empty citation>
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12.4.3. ∞ : 1	<empty citation>
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12.4.4. ∞ : ∞	<empty citation>
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13. Warehouse Management

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13.1.1. Why warehouses?	<empty citation>
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13.1.2. Types of warehouses	<empty citation>
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13.2. Warehousing & Packaging

13.2.1. Foo	<empty citation>
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13.3. Core Operational Functions

13.3.1. Receive	<empty citation>
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13.3.2. Put away	<empty citation>
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13.3.3. Store	<empty citation>
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13.3.4. Pick	<empty citation>
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13.3.5. Check, Pack, Ship	<empty citation>
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13.3.6. Return handling	<empty citation>
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13.3.7. Value-added services	<empty citation>
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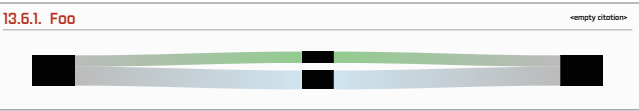
13.4. Layout design

13.4.1. Foo	<empty citation>
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13.5. Cross-Docking

13.5.1. Foo	<empty citation>
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13.6. Segmentation & Benchmarking in Warehousing



13.7. Templates

13.7.1. Consequences of the Axioms

<empty citation>

By set theory definitions we have: $A \cup A^c = \Omega$ and $A \cap A^c = \emptyset$

$P(A) \leq 1$

A and A^c are disjoint $\Rightarrow P(A \cup A^c) = 1 = P(A) + P(A^c) \Rightarrow P(A^c) = 1 - P(A)$, and by *nonnegativity* we get $P(A^c) \geq 0 \Rightarrow P(A) \leq 1$ ■

$P(\emptyset) = 0$

Let $A = \Omega \Rightarrow P(\Omega) + P(\Omega^c) = 1 \Rightarrow 1 + \emptyset = 1 \Rightarrow P(\emptyset) = 0$ ■

Let Ω be a finite set and A_1, \dots, A_n be disjoint events, then:

$P\left(\bigcup_{i=1}^n A_i\right) = \sum_1^n P(A_i)$

$P(A \cup B \cup C) = P[(A \cup B) \cup C]$. From additivity, given that the events are disjoint, we have $(P(A) + P(B)) + P(C)$. By induction we can extend this to n disjoint sets ■

Let $\{\omega_1, \dots, \omega_k\}$ be a discrete, finite set of sample points, then:


$P\left(\{\omega_1, \dots, \omega_k\}\right) \Rightarrow P\left(\bigcup_{j=1}^k \{\omega_j\}\right) \Rightarrow \sum_{j=1}^k P\left(\{\omega_j\}\right)$

because $\{\omega_1, \dots, \omega_k\}$, can be seen as the union of *unit sets*, and since they are disjoint, additivity applies ■. Although, a simpler, non rigorous notation can be used: $\sum_{j=1}^k P(\omega_j)$.

13.7.2. More Consequences of the Axioms

<empty citation>

Consider the condition $P(A \cap B) \geq 0$, \Rightarrow The events could be joint, therefore, more generally:


 $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Which can be generalized to the...:

$P\left(\bigcup_{i=1}^n A_i\right) = - \sum_{k=1}^n (-1)^k \sum_{1 \leq i_1 < \dots < i_k \leq n} P\left(\bigcap_{j=1}^k A_{i_j}\right)$


From the above, the *Union Bound* property follows: $P(A \cup B) \leq P(A) + P(B)$

Consider that A is included in B , then:

 $A \subset B \Rightarrow P(A) \leq P(B)$

since $B = A \cup (B \cap A^c) \Rightarrow P(B) = P(A) + P(B \cap A^c) \geq P(A)$ ■

Consider 3 sets not necessarily disjoint, e.g.:

 $P(A \cup B \cup C) = P(A) + P(A^c \cap B) + P(A^c \cap B^c \cap C)$

Visually, we can check the boxed expression by the matching of the colors, and since the subsets are disjoint, additivity holds. Notice the expression also applies to disjoint sets ■

13.7.3. Multiplication Rule

<empty citation>

Notice that:

$P(A \cap B) = P(B)P(A|B)$
 $= P(A)P(B|A)$

And for 3 events we have:

$P[(A \cap B) \cap C] = P(A \cap B)P(C|A \cap B)$
 $= P(A)P(B|A)P(C|A \cap B)$

More generally:

$P\left(\bigcap_{i=1}^n A_i\right) = P(A_1) \prod_{i=2}^n P\left(A_i \middle| \bigcap_{j=1}^{i-1} A_j\right)$

A particular intersection of events would be represented as a full path in a probability tree.

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