**FLEX Supply Chain Management Simulation**

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# Chapter 1: Introduction

## Purpose

The FLEX simulation is designed to provide a comprehensive learning experience in supply chain management and production strategy. It focuses on the dynamic and complex interactions within a manufacturing environment, offering insights into efficient resource management, production planning, and the benefits of a postponed production strategy.

## Industry Context

The simulation is set in the consumer electronics industry, featuring a company that produces two generic products: a Smart Home Assistant and a Smart Thermostat. These products share common subassemblies and raw materials, allowing for streamlined procurement and production processes.

## Learning Objectives of the FLEX Simulation

The learning objectives implicit in the FLEX simulation include the following:

* **Gaining Exposure to Supply Chain Elements and Their Interactions:**
  + Understand the individual components of the supply chain, including procurement, production, inventory management, and distribution, and how they interact to form an integrated system.
* **Appreciating the Need for Balance and Managing Trade-Offs:**
  + Learn to balance various aspects of the supply chain, such as cost, quality, speed, and flexibility, and understand the trade-offs involved in optimizing overall performance.
* **Experiencing Competitive Dynamics in an Evolving Marketplace:**
  + Simulate the competitive pressures and market dynamics that influence supply chain decisions, allowing participants to develop strategies for maintaining a competitive edge.
* **Appreciating Information Flows and Integration with Decision Making:**
  + Gain insights into the critical role of information flows within the supply chain and learn how to integrate this information into effective decision-making processes.
* **Enhancing and Encouraging Fact-Based Analysis and Decision Making:**
  + Foster the ability to conduct fact-based analysis using data from the simulation, encouraging informed and evidence-based decision making in supply chain management.
* **Gaining Familiarity with Financial Statements in For-Profit Businesses:**
  + Become familiar with financial statements commonly used in for-profit businesses, such as income statements, balance sheets, and cash flow statements, and understand their relevance to supply chain management.

## Goal of the Learning Objectives

The goal of these learning objectives in the FLEX simulation is to equip participants with the knowledge, skills, and practical experience necessary to excel in supply chain management and production planning. Specifically, the objectives aim to:

1. **Develop Comprehensive Understanding:**

* Enable participants to gain a thorough understanding of the entire supply chain, from raw material procurement to final product delivery, and the interactions between various supply chain elements.

1. **Enhance Strategic Decision-Making:**

* Foster the ability to make strategic decisions by appreciating the need for balance and understanding the trade-offs involved in optimizing supply chain performance.

1. **Adapt to Market Dynamics:**

* Prepare participants to navigate competitive dynamics and evolving market conditions, allowing them to develop and implement effective supply chain strategies in real-world scenarios.

1. **Integrate Information for Better Outcomes:**

* Improve participants' ability to utilize information flows and integrate data into their decision-making processes, leading to more informed and effective supply chain management.

1. **Encourage Analytical Thinking:**

* Promote fact-based analysis and encourage participants to rely on data and evidence in their decision-making, enhancing their analytical and critical thinking skills.

1. **Understand Financial Implications:**

* Provide participants with a solid understanding of financial statements and their implications for supply chain management, enabling them to make financially sound decisions.

1. **Prepare for Real-World Challenges:**

* Equip participants with practical experience and skills that are directly applicable to real-world supply chain and production planning challenges, preparing them for success in their professional careers.

By achieving these objectives, participants will be better prepared to manage and optimize supply chains, improve production efficiency, and contribute to the overall success and competitiveness of their organizations.

## FLEX Overview

FLEX is a comprehensive supply chain management simulation that encompasses all major elements of the supply chain, including suppliers, manufacturers, distributors, retailers, and end-users. Firms participating in FLEX are responsible for managing a wide range of activities, including:

* **Procurement**
* **Manufacturing**
* **Distribution and warehousing**
* **Transportation**
* **Customer service**
* **Demand management**
* **Forecasting**
* **Enterprise Systems**

Each decision period in FLEX represents one calendar quarter.

## Business Operations in FLEX

In FLEX, you manufacture, distribute, and sell:

1. Smart home assistants
2. Smart thermostats

You sell in three regional markets:

* Region 1 (manufacturing plant and one distribution center are located here)
* Region 2 (there is no manufacturing plant or DC in region 2 at the start of the simulation)
* Region 3 (there is no manufacturing plant or DC in region 3 at the start of the simulation)

Your manufacturing plant is located in market region 1 (your home region). Distribution centers in each market region inventory your products, fill orders from the retail and direct channels, stock inventories of sub-assembly components for replacement parts for within-warranty failures, and provide customer service. Your distribution center in region 1 is located adjacent to your manufacturing plant and shares inventory of sub-assembly components with your manufacturing plant.

The "product" in FLEX includes smart home assistants and smart thermostats. These high-tech electronics products are purchased by individual consumers for home use and by a wide range of businesses for office and operational environment.

|  |  |
| --- | --- |
| Decision Areas | Specific Decisions |
| Procurement | Raw materials: Plastics and Metals (P&M’s)  Sub-assemblies:  Motherboard (Sub Assembly A)  Casing (Sub Assembly B)  Com Module (Sub Assembly C) |
| Manufacturing | Production volumes Postponed production volumes Emergency production limits Production volume capacity |
| Distribution | Distribution center presence in regional markets RFID-application process for retail-channel sales  Emergency carrier for plant-DC finished-goods shipments Cross-docking  Surface shipping methods |
| Transportation | Volumes and modes for inbound sub-assembly components Shipment volumes and modes for plant-to-DC finished goods |
| Service | Service outsourcing |
| Demand Management | Introduction/drop in market regions and channels Price for each product, channel, and region  Marketing spending for each product, channel, and region |
| Forecasting | Sales volume forecasts |
| Information Technology | Information technology options |

# Chapter 2: Product Description

Your firm has two products: a Smart Home Assistant (SHA) and a Smart Thermostat (ST) product.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Product 1:  Smart Home Assistant | Product 2:  Smart Thermostat | Definitions |
| Configuration Elements | "SHA"  Plastics  Casings  Warranty  Packaging | "ST"  Plastics  Casings  Warranty  Packaging | 5 Kg  5 Kg  4 Quarters  Stnd ("1"), Prem ("2"), or ES Prem ("3") |
| Sub-Assembly Components | Motherboard (1 unit)  Audio Module (AM) (1 unit) | Motherboard (1 unit)  Control Interface (CI) (I unit) |  |

## Warranty Costs

**No Warranty**: No associated costs.

* **With Warranty**: The cost is calculated as $8 + 3(QQ), where Q is the warranty length in quarters.
  + Example Costs:
    - 1-quarter warranty: $11
    - 2-quarter warranty: $20
    - 3-quarter warranty: $35
    - 4-quarter warranty: $56
* Warranty coverage is outsourced to a service provider in each market region, with costs paid directly at the time of product manufacturing. These costs do not depend on the failure rates of the sub-assembly components. Manufacturers are responsible for replacing sub-assembly components that fail during the warranty period, which includes the original quarter of sale plus the number of warranty quarters.

## Packaging

* Standard ("1"): $10
* Premium ("2"): $14
* Environmentally Sensitive Premium ("3"): $28
  + Premium packaging may increase demand and offers better protection during shipping, potentially reducing failure rates in the field. The "3" packaging option denotes environmentally sensitive design, construction, and materials.

# Chapter 3: Procurement Decisions

Your FLEX firm manages procurement by sourcing raw materials and sub-assembly components from suppliers. If postponed production is chosen, similar inventory management decisions are required at regional distribution centers where postponement occurs.

## Sub-Assembly Components and Warranty

Sub-assembly components may fail in the field as customers use their products. Within the warranty period, replacement parts are provided at no cost. Each regional distribution center services the demand for replacement parts from its local region. If a regional distribution center does not exist, the demand is sourced from the distribution center adjacent to the manufacturing plant in market region 1.

## Emergency Procurement

If the available inventory of any raw material or sub-assembly component is insufficient to meet production requirements, an emergency procurement order is automatically executed by the simulation software.

## Raw Materials

* **Plastics and Casings**: Widely available single-grade commodities purchased at worldwide spot-market prices.
  + **Transportation**: Covered by suppliers, typically surface transportation.
  + **Delivery**: Always within the current quarter.
  + **Current Prices**: $3/kg for Plastics and $4/kg for Casings.
  + **Volume Discounts**:
    - 7.6% discount for procurements over 250,000 kg.
    - 13.8% discount for procurements over 500,000 kg.
    - 19.2% discount for procurements over 1,000,000 kg.
* **Emergency Orders**: Incurs an additional $1/kg transportation charge.

## Sub-Assembly Components and Supplier Decisions

* **Products:**
  + **Smart Home Assistant (SHA)**: Includes sub-assembly component Audio Module (AM).
  + **Smart Thermostat (ST)**: Includes sub-assembly component Control Interface (CI).
  + **Common Subassembly**: Both products use the Motherboard sub-assembly component.
* **Suppliers:**
  + **AM**: Sourced from suppliers A, B, C, or D.
  + **CI**: Sourced from suppliers B, C, D, E, or F.
  + **Motherboard**: Sourced from suppliers D, E, F, or G.
* **Delivery:**
  + AM and CI: Available on the spot-market for immediate delivery.
  + Motherboard: Delivered one quarter after ordering.
* **Transportation Costs:**
  + AM and CI: $3/unit (surface), $4/unit (air).
  + Motherboard: $4/unit (surface), $6/unit (air).
  + Emergency Orders: 50% higher than air transportation costs.
* **Volume Discounts:**
  + 10.4% discount for procurements over 50,000 units.
  + 17.5% discount for procurements over 100,000 units.

## Sub-Assembly Component Characteristics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Supplier | Component | Cost | Delivery Rate | Failure Rate |
| AM | | | | |
| Supplier A | AM | $12 | 80% ± 2% | 2.0% |
| Supplier B | AM | $14 | 85% ± 4% | 1.9% |
| Supplier C | AM | $13 | 85% ± 6% | 2.0% |
| Supplier D | AM | $22 | 90% ± 8% | 1.2% |
| CI | | | | |
| Supplier B | CI | $15 | 75% ± 4% | 2.6% |
| Supplier C | CI | $16 | 78% ± 6% | 2.5% |
| Supplier D | CI | $24 | 80% ± 8% | 1.8% |
| Supplier E | CI | $14 | 70% ± 10% | 2.7% |
| Supplier F | CI | $13 | 70% ± 12% | 2.8% |
| Motherboard | | | | |
| Supplier D | Motherboard | $29 | 80% ± 8% | 1.1% |
| Supplier E | Motherboard | $20 | 75% ± 10% | 1.7% |
| Supplier F | Motherboard | $19 | 77% ± 12% | 1.8% |
| Supplier G | Motherboard | $21 | 78% ± 14% | 1.7% |

## Inventory Management for Postponed Production

FLEX firms produce complete smart home assistants and smart thermostats at their manufacturing plant and ship them through their regional distribution centers to customers. Alternatively, postponement is possible by producing semi-finished products. Postponed production involves creating a semi-completed product at the manufacturing plant, which can later be converted into either SHA or ST at the distribution center.

If your firm practices postponed production, sub-assembly components inventories must be managed at your regional distribution centers. And, if you are currently manufacturing completed products at your manufacturing plant, inventories of sub-assembly components also have to be managed at the manufacturing plant. Recall that your manufacturing plant shares inventories with your distribution center in market region 1.

Negative shipments of raw materials and sub-assembly components (i.e., returns to vendors) are not possible. The FLEX software automatically disposes of any residual inventory of sub-assembly components and finished goods when a DC is closed. The inventory is converted to cash at the current balance-sheet values and a corresponding disposal cost of 20% of the inventory's value accrues. This disposal cost is recorded under Consulting Fees on the firm's P&L statement. An appropriate disposal-sale message appears at the end of the firm's financial statements.

## Replacement Parts

Sub-assembly components may fail in the field as customers use their products. Within the warranty period associated with each product, replacement parts are provided without cost by the firm.

Each regional distribution center services demand for sub-assembly component replacement parts from the local region. If a particular regional distribution center does not exist, then replacement part demand from that region is sourced from the distribution center adjacent to the firm's manufacturing plant in market region 1. Your FLEX firm must maintain a suitable inventory of sub-assembly components to service replacement parts demand.

## Emergency Procurement

Your firm has a policy of never running out of inventories of raw materials or sub-assembly components. If the available inventory of any raw material or sub-assembly component is insufficient to meet the requirements implicit in your production orders, an emergency procurement order is automatically executed by the simulation software.

Emergency procurement orders of sub-assembly components are made from supplier D, the only full-service supplier offering all sub-assembly components. Emergency procurement orders of raw materials and sub-assembly components involve extra charges of $1/kg and $3/unit, respectively ($6/unit for Motherboard sub-assembly components). Emergency procurement costs are recorded as "Emergency Procurement" costs on the "Corporate P&L Statement."

Emergency orders are always shipped by air to ensure they arrive in time for the current quarter's production activities. Emergency orders of sub-assembly components involve transportation costs that are 50% higher than the usual costs associated with sourcing via air transportation. Emergency procurement of raw materials incurs a cost of $1/kg.

## Relationship Management Costs

Each relationship with a sub-assembly supplier incurs one-time start-up costs of $20,000, plus ongoing costs of $10,000 in the initial quarter of procurement and $5,000 in subsequent quarters as long as your firm continues to source sub-assembly components from a supplier. If you cease ordering sub-assembly components from a supplier and then start ordering again in a later quarter, these start-up costs are incurred again.

“Relationship" means one or more purchase orders processed with a sub-assembly component provider. Relationship management costs are recorded under "Procurement FC" on your financial statements.

Fixed order costs of $1,250 accrue for every sub-assembly component procurement (via surface or air) from every supplier used in a quarter. These costs are also recorded under “Procurement FC” on your financial statements.

Ongoing relationships with sub-assembly component suppliers have the positive benefit of reducing the risk associated with spot-market unavailability in any given quarter. As an existing customer of a sub-assembly component supplier, your firm would receive preferential treatment with regard to any supply constraints. Thus, your firm would normally not face spot-market unavailability from your existing sub-assembly component suppliers.

## SAC Surface Shipping

SAC surface shipping, a distribution decision variable in FLEX, refers to in-bound surface shipments of sub-assembly components to each DC.

* **Expedited Surface Shipping (Level 3)**: Increases delivery reliability by 10%-20%, costs 25% above the standard surface shipping cost.
* **Standard Surface Shipping (Level 2)**: The normal form of surface shipping for in-bound sub-assembly components to each DC. Standard surface delivery reliability parameters are specified in the table above.
* **Economy Surface Shipping (Level 1)**: Reduces shipping costs by 30%, decreases delivery reliability by 35%-40%.

Transportation costs are reported in the FLEX financial reports for standard surface shipping. Incremental adjustments in transportation costs for expedited surface shipping and economy surface shipping accrue as Transportation Rebates. Expedited surface shipments are reflected as negative Transportation Rebates while economy surface shipments are reflected as positive Transportation Rebates.

# Chapter 4: Manufacturing Decisions

Your FLEX firm makes production decisions for each of your products each quarter. The FLEX production sub-process is build-to-plan (build-to-stock).

## Postponed Production

Postponed production involves creating a partially completed product, called a "SHELL," at your firm's manufacturing plant. Postponed production occurs at your regional distribution centers and involves converting the SHELL into specific finished goods. With postponed production, the final product identity is assigned at the distribution center (DC), not at the manufacturing plant. Postponed production has the potential to reduce demand-supply imbalances at distribution centers since not all products shipped to the distribution centers have to be completely finished. SHELLS may be converted into either SHA or ST to meet local demand variations across your product line. Postponed production is only possible with an owned DC, not with a third-party DC.

## Emergency Production Limits

In addition to production decisions, you also control product-specific emergency production limits. If finished goods inventory is insufficient to meet end-user demand, an emergency production order is executed automatically up to the product's specified emergency production limit.

## Production Volume Flexibility

Production volume flexibility decisions permit you to exceed quarter-over-quarter production order change limits (maximum change of 10,000 units from the previous quarter’s production level).

Unfilled orders can exist in your industry. If demand for any product exceeds the product’s emergency production limit, customer sales and scheduled product shipments to other DCs must be reduced proportionately by the amount that orders exceed the product’s emergency production limit. The difference between potential customer sales (orders) and actual customer sales due to inadequate on-hand finished goods inventory (after accounting for a product's emergency production limit) is termed "unfilled orders" in FLEX. Unfilled orders are not backlogged orders and are not guaranteed future sales.

Past experience in the products industry suggests that 8%-12% of sales result in returns, but this can be higher if unfilled orders exist.

## Manufacturing Process & Decisions

Your FLEX firm makes production decisions for each of your products each quarter. These production volume decisions include both completed products and postponed production. In addition, you must decide on emergency production limits for each completed product each quarter.

Postponed production involves creating a partially completed product, referenced as product "0," at your firm's manufacturing plant. Inventories of product "0" are tracked from your manufacturing plant to your distribution centers. Postponed production occurs at your regional distribution centers and involves converting product "0" into specific finished goods. Postponed production allows the final product identity to be assigned at the distribution center, reducing demand-supply imbalances.

## Manufacturing and Postponed Production Costs

The costs associated with manufacturing and postponed production are described in Exhibit 6. DC-specific costs refer to the incremental production costs associated with converting postponed-production units into either SHA or ST completed products. There is a fixed cost per order associated with setting up each production run, whether at the manufacturing plant or for postponed production at any distribution center. In addition to these production-related costs, the implied costs associated with the configurations of the products are also added to the costs of the products.

Production volumes for each product (including postponed production [product 0]) can change by a maximum of 10,000 units from the previous quarter's value. You may, however, change a product's production volume to 0 units at any time, but you'd then be limited to a maximum production volume of 10,000 units in the following quarter. This constraint is due to load balancing requirements associated with available plant capacity and labor force overtime scheduling requirements.

In addition to the order-related fixed costs and the unit-related variable costs described below, your firm absorbs costs associated with depreciation and maintenance of your dedicated plant capacity to manufacture products. These costs are $100,000 per quarter for each production "shift," and they are recorded as "Plant Capacity FC" (plant capacity fixed costs) on your "Corporate Current P&L Statement." These costs are allocated equally among your products.

## Manufacturing Costs (Per Unit)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Manufacturing Plant | DC1 | DC2 | DC3 |
| Postponed Production | | | | |
| Fixed Costs (per order) | $20,000 | - | - | - |
| Labor Costs (per unit) | $22 | - | - | - |
| Production Costs (per unit) | $11 | - | - | - |
| SHA | | | | |
| Fixed Costs (per order) | $22,500 | $5,000 | $5,000 | $4,000 |
| Labor Costs (per unit) | $30 | $14 | $15 | $12 |
| Production Costs (per unit) | $20 | $12 | $14 | $11 |
| ST | | | | |
| Fixed Costs (per order) | $24,500 | $6,000 | $8,000 | $5,000 |
| Labor Costs (per unit) | $36 | $16 | $20 | $15 |
| Production Costs (per unit) | $16 | $10 | $12 | $10 |

*Note: DC-specific "Postponed Production" costs are incremental, above and beyond "Postponed Production" costs recorded in the "Manufacturing Plant" column. For example, the total fixed costs (per order) associated with postponed production for SHA completed at DC1 are $20,000 + $5,000 = $25,000.*

## Emergency Production

In addition to production decisions, you also control product-specific emergency production limits, which are a maximum of 10,000 units per product. If end-user demand exceeds available inventory plus postponed production inventory (SHELLS) plus your emergency production limit, additional end-user demand becomes unfilled orders. There is a $2/unit [$3/unit] cost for standby charges associated with all emergency production limits for SHA [ST] products. These standby charges are levied regardless of whether you actually use the specified emergency production limits during a quarter. Emergency production costs are recorded under "Emergency Production" on the "Corporate P&L Statement."

If finished goods inventory is insufficient to meet end-user demand, an emergency production order is executed automatically up to the product's specified emergency production limit:

1. **Access Postponed Production Inventory**: If you have available postponed production inventory at a regional distribution center, it is automatically accessed to cover emergency production requirements. Postponed production inventory accessed for emergency production purposes has no additional labor and production costs other than those described in Exhibit 6. If no inventory of postponed production is available at your distribution center, then your finished goods inventory at your manufacturing plant (distribution center in market region 1) is accessed. Air shipment is always used for such emergency inventory situations, with a 50% premium above normal air shipment rates.
2. **Execute Emergency Production**: If your distribution center in market region 1 has no available finished goods inventory, an emergency production order is executed at your manufacturing plant. Emergency production orders have an associated 50% cost premium (i.e., labor and production costs are 50% higher than standard) for emergency production volumes up to the product's specified emergency production limit. For emergency production exceeding 5,000 units, the premiums are 100% above standard rates. Emergency production finished goods inventory is shipped via air at a 50% premium above normal air shipment rates.

You have complete control over whether to use emergency production for any product. If you set a product's emergency production limit to 0, then either postponed production would be invoked (if product 0 inventory is available) or unfilled orders would result. You'll need to assess the trade-offs between emergency production and unfilled orders.

Emergency production orders might also necessitate emergency raw materials or sub-assembly component orders if there is insufficient available on-hand inventory at your manufacturing plant. Thus, the overall cost impact of emergency production orders can extend beyond just the emergency production order costs highlighted above.

## Production Volume Flexibility

Each product’s production order volume may not change by more than 10,000 units from the previous quarter’s production order volume for that product. Larger changes must be phased in over successive quarters. However, a change to 0 units of production order volume for a product is always possible, but the following quarter’s production for that product would be limited to a maximum of 10,000 units.

You may enhance your firm’s manufacturing technology to provide greater production volume flexibility, with associated costs detailed below:

|  |  |
| --- | --- |
| Incremental Production Order Volume Flexibility | Cost |
| 1 to 2,500 Units | $2/unit |
| 2,501 to 5,000 Units | $5,000 plus $4/unit over 2,500 units |
| 5,001 to 7,500 Units | $15,000 plus $6/unit over 5,000 units |
| 7,501 to 10,000 Units | $30,000 plus $8/unit over 7,500 units |
| 10,001 to 12,500 Units | $50,000 plus $10/unit over 10,000 units |

In addition to these costs, any change in a product’s production volume flexibility costs $10,000 in one-time fixed costs. These costs are recorded as “Production FC” on your Corporate P&L Statement.

“Incremental production order volume flexibility” refers to the extra flexibility in a product’s production volume change limit from quarter to quarter, beyond the standard allotment of 10,000 units for each product. For example, suppose that you select 4,200 units of incremental production order volume flexibility for a product. Then, that product’s production volume could change by a maximum of 14,200 units (10,000 units from the standard allotment plus 4,200 in [optional] incremental production volume flexibility) from the previous month’s production volume for that product.

Production volume flexibility is specific to each product. Thus, you may provide for some incremental production volume flexibility (over the standard allotment of 10,000 units) for one product but not for others. Incremental production volume flexibility is possible for product 0, like all other products.

# Chapter 5: Distribution Decisions

## Overview

Distribution decisions in FLEX include determining whether to have distribution centers (DCs) in regions other than your home-base (Region 1) and, if so, deciding the form of those DCs (outsourced vs. owned). For each region-specific DC, you also face decisions related to RFID application for products distributed through the retail channel (Channel #1), whether to enable cross-docking with one or more carriers, and surface shipping methods for finished goods inventory shipped from DC1 to other DCs and for inbound surface shipments of sub-assembly components to each DC.

Even if you choose not to have a distribution center in a market region other than Region 1, you can still have sales in that market region if you choose to have products in active distribution in any channel in that market region. Such sales would be serviced directly from your Region 1 DC.

Retailers require your products to be equipped with RFID (radio-frequency identification). RFID is applied to your outbound products at your distribution centers. Only products distributed to the retail channel (Channel #1) require RFID application. At each distribution center, you may use outsourced or insourced RFID application.

With cross-docking enabled at a DC, inventory holding costs and DC operating costs are reduced because inbound shipments are directly transferred to outbound carriers with reduced regional-DC handling, warehousing, and administration. Cross-docking is possible at all regional DCs (i.e., at third-party and owned regional DCs) other than DC1.

Surface shipping methods provide three levels of surface shipping for finished goods shipments from DC1 to other DCs and for inbound surface shipments of sub-assembly components to each DC. Surface shipping methods include expedited, standard, and economy surface shipping with associated consequences for surface shipping delivery reliability and cost.

## Distribution Center Decisions

While you must always have an owned DC in Region 1, you may or may not wish to have DCs in other regions. If you choose not to have a distribution center in a market region other than Region 1, sales in that market region would be serviced directly from your Region 1 DC.

If you have a distribution center in a market region:

* Replacement parts demand is fulfilled from that regional DC, requiring inventories of sub-assembly components to be maintained at those regional DCs.
* Postponed production is possible with owned "local" region distribution centers, requiring inventorying of sub-assembly components at that regional DC.
* When a regional distribution center opens, there will be no inventory of the Motherboard sub-assembly component available at that DC for the first quarter. All first-quarter usage of the Motherboard will be on an emergency basis, with consequent first-quarter emergency ordering costs.
* Transportation of finished goods to customers from a regional DC is via surface transportation. Otherwise, air transportation is required to ship finished goods from the distribution center in Region 1 to customers in other regions without a local distribution center.

Three distribution center decision options exist in regions other than Region 1:

1. **Decision Option "0" (no distribution center):** No distribution center costs exist.
2. **Decision Option "1" (outsourced third-party distribution center):** Involves outsourcing your regional distribution center to a reputable partner in a region. This option includes one-time costs of $100,000 to open, $50,000 in one-time costs to close, $50,000 in quarterly costs, and inventory charges of 5% based on the inventory value.
3. **Decision Option "2" (operate owned distribution center):** Involves one-time costs of $250,000 to open, $150,000 in one-time costs to close, $25,000 in quarterly costs, and inventory charges of 3% based on the inventory value.

Your firm can only have one DC in a region. The DC status code “2” denotes an owned DC in a region, not two DCs in that region. DC openings and conversions (from outsourced to owned or vice versa) occur at the start of the next quarter. Existing inventory is automatically transferred to the new DC form. The FLEX software automatically disposes of residual inventory of sub-assembly components and finished goods when a DC is closed. The inventory is converted to cash at the current balance-sheet values and a corresponding disposal cost of 20% of the inventory's value accrues.

## RFID Application for Retail-Channel Sales

Retailers now require that your products be equipped with RFID. RFID is applied to your outbound products at your distribution centers. Only products distributed to the retail channel (Channel #1) require RFID application.

At each distribution center, you have two choices for RFID application:

1. **Decision Option 0 (outsourced RFID application)**: Adds $11 in variable costs to all products sold through the retail channel.
2. **Decision Option 1 (insourced RFID application)**: Requires a one-time investment of $350,000, reducing variable costs to $1 per product sold through the retail channel. This investment is recorded under "Consulting Fees" on your corporate profit-and-loss statement. RFID insourcing is only possible if you already have or simultaneously open a DC in a region.

Your RFID decision is specific to each distribution center. Thus, you may choose to insource at some DCs and outsource at others.

## Emergency Carriers for Plant-to-DC Shipments

You must choose an emergency carrier for each of your DCs (other than DC1). This emergency carrier is used for plant-to-DC transportation shipments required on an emergency basis.

## Cross-Docking

Cross-docking reduces inventory holding costs and DC operating costs by directly transferring inbound shipments to outbound carriers with reduced handling, warehousing, and administration. Cross-docking is possible at all regional DCs (other than DC1) with carriers K, L, M, and N.

## Costs and Benefits:

* **One-time fixed costs**: $7,500 per carrier.
* **Ongoing (quarterly) maintenance costs:** $2,500 per carrier.
* **Reduced inventory charges**: 0.5% reduction, with a maximum inventory valuation of $5,000,000.
* **Reduced quarterly DC operating costs**: $1,000 per carrier enabled at a regional DC other than DC1.

Cross-docking costs on the “Corporate P&L Statement” reflect the net costs (positive or negative) associated with cross-docking, including the reduction in finished goods inventory charges associated with cross-docked shipments.

At each distribution center (other than DC1), you have two choices for cross-docking with carriers K, L, M, and N:

1. **Decision Option 0**: No cross-docking exists.
2. **Decision Option 1**: Cross-docking is enabled with a specific carrier.

Cross-docking involves inbound shipments from DC1 to another DC. If there are no inbound shipments to a DC via a carrier with cross-docking enabled in a particular quarter, there are no cross-docking cost savings for that carrier in that quarter.

## Surface Shipping Methods

Surface shipping methods provide three levels of surface shipping for finished goods shipments from DC1 to other DCs and for inbound surface shipments of sub-assembly components to each DC. These methods include expedited, standard, and economy surface shipping with associated consequences for delivery reliability and cost.

Finished Goods Inventory (FGI) Surface Shipping:

Specific to each DC (other than DC1) and applies to all carriers' surface shipments of finished goods from DC1 to that DC. Details are provided in Chapter 7 (Transportation Decisions).

Sub-Assembly Components (SAC) Surface Shipping:

Provides three levels of surface shipping for inbound sub-assembly components to each DC. Details are provided in Chapter 4 (Procurement Decisions).

# Chapter 6: Transportation Decisions

## Overview

The FLEX transportation decisions include choosing transportation modes (surface and air) for inbound sub-assembly components and selecting transportation modes and carriers for finished goods shipments from your plant to your distribution centers (DCs).

* **Surface Transportation**: Less expensive but less reliable than air transportation.
* **Air Transportation**: More expensive but offers 100% delivery reliability within the current quarter.

For regions other than Region 1, transportation decisions are required to ship your products to regional DCs. You make shipment volume decisions across two possible transportation modes (surface and air) and six possible carriers (I, J, K, L, M, and N). Carriers offer a 20% rebate on the current quarter's transportation charges if they are used exclusively.

You must also choose an emergency carrier for each of your DCs (other than DC1) for emergency shipments.

## Transportation Responsibilities

Different kinds of transportation decisions are required in different parts of your supply chain:

* **Inbound Raw Materials**: Vendors provide inbound transportation as part of their bundled prices. No decisions required.
* **Inbound Sub-Assembly Components**: Joint responsibility between suppliers and manufacturers. Suppliers quote unbundled component and transportation mode costs. Manufacturers choose modes; suppliers arrange carriers.
* **Plant-to-DC Shipments**: Manufacturers are responsible for transportation decisions related to within-firm shipments of postponed production and finished goods from plants to DCs.
* **DC Shipments to Customers**: Ship by surface from within-region DCs or by air from DC1 if no local DC exists. No active decisions required.

## Plant-to-DC Shipments

The regional DC in Region 1 is located adjacent to your manufacturing plant, so there are no transportation costs for shipments to DC1. For other regions, transportation decisions are required. You make shipment volume decisions across surface and air transportation modes and carriers I, J, K, L, M, and N.

Based on past experience, air transportation ensures 100% delivery reliability within the current quarter, while surface transportation averages about 70% delivery reliability. Current transportation costs per unit between your plant and regional DCs for all carriers are shown in Exhibit 9.

## Plant-to-DC Transportation Shipments

|  |  |  |  |
| --- | --- | --- | --- |
| Carrier | Market Region 1 | Market Region 2 | Market Region 3 |
|  | Cost | Delivery | Cost |
| Carrier I, Surface | $6 | 70% ± 4% | $10 |
| Carrier I, Air | $8 | 100% | $14 |
| Carrier J, Surface | $4 | 40% ± 8% | $4 |
| Carrier J, Air | $10 | 100% | $14 |
| Carrier K, Surface | $6 | 70% ± 12% | $6 |
| Carrier K, Air | $8 | 100% | $14 |
| Carrier L, Surface | $8 | 75% ± 4% | $6 |
| Carrier L, Air | $10 | 100% | $14 |
| Carrier M, Surface | $6 | 65% ± 8% | $8 |
| Carrier M, Air | $8 | 100% | $16 |
| Carrier N, Surface | $10 | 82% ± 12% | $12 |
| Carrier N, Air | $12 | 100% | $18 |

## Customer Shipment Transportation Costs (Per Unit)

|  |  |  |
| --- | --- | --- |
| Market Region | Within-Region Surface Transportation Costs | Sourcing from Plant/DC1 with No Within-Region DC |
|  | Channel 1 | Channel 2 |
| Market Region 1 | $4 | $8 |
| Market Region 2 | $6 | $12 |
| Market Region 3 | $8 | $16 |

Outbound Shipments combine the data from Exhibits 9 and 10 to determine total transportation costs for any choice of plant-to-DC carrier.

## Sample Plant-DC-Customer Total Transportation Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Region | Channel 1 "Local" DC | Channel 1 Air Sourced from Plant/DC1 | Channel 2 "Local" DC | Channel 2 Air Sourced from Plant/DC1 |
| Region 1 | $4 | - | $8 | - |
| Region 2 | $6 + $6 = $12 | $8 + $6 = $14 | $6 + $12 = $18 | $8 + $12 = $20 |
| Region 3 | $10 + $8 = $18 | $14 + $8 = $22 | $10 + $16 = $26 | $14 + $16 = $30 |

Emergency transportation shipments to a regional DC cost 50% more than the current air transportation costs of your designated regional emergency carrier.

## FGI Surface Shipping

FGI surface shipping is specific to each DC (other than DC1) and includes three levels:

1. **Expedited Surface Shipping (Level 3)**: Increases surface shipping delivery reliability by 10%-20%, costs 25% above standard surface shipping cost.
2. **Standard Surface Shipping (Level 2)**: The normal form of surface shipping for finished goods inventory from DC1 to other DCs.
3. **Economy Surface Shipping (Level 1)**: Reduces shipping costs by 30%, decreases surface delivery reliability by 35%-40%.

Transportation costs are reported in the FLEX financial reports for Standard Surface Shipping. Incremental adjustments for Expedited and Economy Surface Shipping accrue as Transportation Rebates.

## Summary

This chapter details the transportation decisions for which you are responsible in FLEX, including transportation mode choice (surface and air) for inbound sub-assembly components and transportation mode choice and carrier selection for finished goods shipments from your plant to your distribution centers (DCs). Making informed transportation decisions will help you manage costs and ensure reliable delivery performance throughout your supply chain.

# Chapter 7: Service Decision

In the FLEX Supply Chain Management Simulation, service management is outsourced to reputable call-center service providers in each region. This approach allows firms to leverage external expertise and infrastructure while focusing on core supply chain activities. Service outsourcing is region-specific, and you can choose from four available service outsourcing levels, in addition to level "0" ("None," which implies no service is provided). The per-call costs and associated guaranteed service quality performance levels ("SQ Guarantee") for each region are detailed below:

## Service Outsourcing Levels and Costs

|  |  |  |  |
| --- | --- | --- | --- |
| Service Outsourcing Level | Region 1 | Region 2 | Region 3 |
| "Minimum" [1] | Cost/Call: $6 | Cost/Call: $7 | Cost/Call: $8 |
| SQ Guarantee: 10% | SQ Guarantee: 10% | SQ Guarantee: 10% |
| "Standard" [2] | Cost/Call: $10 | Cost/Call: $12 | Cost/Call: $13 |
| SQ Guarantee: 20% | SQ Guarantee: 20% | SQ Guarantee: 20% |
| "Enhanced" [3] | Cost/Call: $16 | Cost/Call: $18 | Cost/Call: $21 |
| SQ Guarantee: 30% | SQ Guarantee: 30% | SQ Guarantee: 30% |
| "Premium" [4] | Cost/Call: $24 | Cost/Call: $27 | Cost/Call: $32 |
| SQ Guarantee: 40% | SQ Guarantee: 40% | SQ Guarantee: 40% |

## Service Quality Guarantees

These "SQ Guarantees" are long-run averages. Service-center outsourcers guarantee that perceived service quality won't vary by more than 3% from these averages in any quarter. Costs for call-center service outsourcing are reported as "Service Outsourcing" on your financial and operating reports.

# Chapter 8: Demand Management Decisions

Your FLEX firm is responsible for channel selection, pricing, and marketing spending decisions.

## Introduction/Drop Decisions

You may introduce products into regions or channels not currently active or drop products from regions or channels. Introduction incurs a one-time cost of $300,000 in Channel #1 in any region and $100,000 in Channel #2 in any region. Dropping a product from active distribution in a region or channel incurs no special costs. Introduction costs are recorded under "Introductions" on your financial statements.

To "activate" a product in a channel/region, change the "Active Product?" status to "Yes." To drop a product from active status in a channel or region, change its "Active Product?" status to "No." Once a product is active in a channel/region, it remains active until you make an explicit drop ("No") decision.

You must explicitly introduce or drop a product from a channel and/or region, regardless of your marketing spending and sales volume forecasts. Setting marketing spending to zero does not result in the associated product being dropped from that market region and channel.

If you drop a product from active distribution in a region or channel, you must also reduce the marketing spending to $0. Otherwise, marketing spending will continue to occur, perhaps in anticipation of a future relaunch.

Given the capacity constraints associated with your manufacturing plant, your firm has a policy of limiting simultaneous new product-region-channel launches to a maximum of three in any quarter. For example, if you choose to launch a product in two channels of a region in the same quarter, that action represents a total of two new launches, and only one other launch would be possible in that quarter in any other combinations of channels and regions.

## Channel Decisions

There are two sales channels within FLEX market regions: retail and direct. You may choose to distribute your products in either, both, or neither channel in each market region. ("Neither" is the same as dropping a product from active distribution in a channel and region.)

* **Channel 1: Retail Channel**
  + Serves individual consumers who purchase products for home use and businesses.
  + Retailers stock products along with other similar and complementary electronic products.
  + Provides point-of-purchase support for in-person shoppers.
* **Channel 2: Direct Channel**
  + Firms sell products directly to final customers via an e-commerce channel.
  + The price in the direct channel is the final price paid by customers.

Alternative distribution channels tap into common and distinct customers, partially competing with each other. Some customers only purchase a products product if it's available in their preferred distribution channel, while others shift some of their purchases towards new channels as they become available. Introducing new channels can grow the market by attracting channel-captive customers who did not purchase previously due to the absence of products in their preferred channel.

Differential order processing costs accrue for sales in these two channels in all regions: $4/unit for Channel 1 (Retail) and $24/unit for Channel 2 (Direct).

## Price Decisions

You set prices for each product in each region and channel every quarter. The retail channel price is the bulk-rate price for units purchased for resale by retailers. In the direct channel, you set the final price paid by end-users.

* **Retail Channel Pricing**
  + You set the manufacturer price, which is marked up by retailers.
  + Consult current research studies to determine average retailer prices in various regions.
  + You do not control final selling prices in the retail channel.
* **Direct Channel Pricing**
  + You control the final selling prices as you sell directly to end-users.

Potential cross-channel competition should be considered when setting prices. Higher prices are usually associated with lower demand levels in all markets and channels. Price sensitivities in the markets are unknown, and you will need to learn about price responsiveness through experience and research studies.

Price adjustments incur costs due to managerial efforts, customer-facing communications, and physical costs (menu costs). Each price change for a product in a channel and region costs $10,000 plus $200 per dollar change in price (increase or decrease) and 0.25% of current-quarter revenues. These costs are recorded as "Price Changes" in your firm's profit-and-loss statements in the quarter the price change occurs.

## Marketing Spending Decisions

A marketing spending budget is required for each product in each region and channel. Managed by your firm’s region and channel managers, this budget covers advertising, promotion, and sales force efforts. Allocate funds as you see fit; spending does not have to be equal in all regions and channels.

Corporate policy limits marketing spending variations to $100,000 from their initial values for any product in any channel and region. Marketing spending is believed to increase demand for products, though the relationship between spending and sales is unknown. You'll need to learn about marketing's influence on sales through your experience.

Since channels overlap, marketing spending in one channel of a region will have some spillover influence on customers in the other channel. Marketing efforts typically target a broad audience, not specific channels. If you drop a product from active distribution in a region or channel, reduce the marketing pending to $0. Otherwise, marketing spending will continue, potentially in anticipation of a future relaunch.

# Chapter 9: Forecasting Decisions

Good forecasts are important. In FLEX, quarterly sales volume forecasts are required for retail and direct channel sales in each region for each of your products. While explicit recorded replacement parts forecasts are not required, you will need to forecast replacement parts demand to manage your inventories of sub-assemblies.

## Impact of Forecasting Accuracy

Accurate forecasting is critical for managing administrative overhead costs. For every 1% inaccuracy in your sales volume forecasts, administrative overhead costs increase by 1%. For example, a forecast error of 10% (whether positive or negative) for a product in a region increases the administrative overhead costs for that product in that region by 10%.

* **Maximum Penalty**: The maximum administrative overhead penalty associated with sales forecasting inaccuracy for each product in each region is a doubling of administrative overhead.
* **Forecast Error Costs**: Forecast error costs are recorded as “Forecast Inaccuracy” costs on your firm’s profit-and-loss statements. The reported base administrative overhead costs are always $80,000/quarter and $120,000/quarter per product in channels 1 and 2, respectively, in all market regions.

Sales volume forecasting decisions are independent of your procurement and production decisions. Sales volume forecasting decisions are your best estimates of customer demand. However, your actual procurement and production decisions will be based on additional factors, such as fixed order costs and target inventory levels.

## Forecasting Accuracy Calculation

Forecasting accuracy is one of the components of the multi-factor FLEX performance evaluation scorecard described in Chapter 15. Forecasting accuracy influences operating performance both directly (via adjustments in base administrative overhead for forecasting inaccuracies) and indirectly (via inventory pipeline inefficiencies [too much or too little inventory]).

* **Forecasting Accuracy Formula**:

Forecasting Accuracy=100×(1−∣Forecast−Actual∣Actual)\text{Forecasting Accuracy} = 100 \times \left(1 - \frac{|\text{Forecast} - \text{Actual}|}{\text{Actual}}\right)Forecasting Accuracy=100×(1−Actual∣Forecast−Actual∣​)

* + **For example**, a forecast value of 11,000 and an actual value of 8,000 results in a forecasting accuracy of:

100×(1−∣11,000−8,000∣8,000)=100×(1−3,0008,000)=100×(1−0.375)=62.5%100 \times \left(1 - \frac{|11,000 - 8,000|}{8,000}\right) = 100 \times \left(1 - \frac{3,000}{8,000}\right) = 100 \times (1 - 0.375) = 62.5\%100×(1−8,000∣11,000−8,000∣​)=100×(1−8,0003,000​)=100×(1−0.375)=62.5%

The minimum possible value of forecasting accuracy is 0.0%. For example, with an actual sales volume of 8,000, a forecast above 16,000 results in a forecasting accuracy score of 0.0%.

# Chapter 10: Enterprise Integration

Effective enterprise integration is essential for optimizing supply chain operations and ensuring seamless collaboration with partners. In the FLEX Supply Chain Management Simulation, you are responsible for making strategic decisions that enhance Enterprise IT integration across your firm's supply chain and with external partners.

## IT Synchronization with Plant-To-DC Carriers

You coordinate your transportation needs with specific plant-to-DC carriers via IT synchronization efforts. By linking your IT system with those of partners, an enhanced degree of supply chain synchronization is achieved in transportation with corresponding improvements in surface transportation delivery performance.

The specifics of plant-to-DC carrier IT synchronization within FLEX are as follows:

1. **Setup and Maintenance Costs**: IT synchronization involves a one-time cost per carrier to implement initially and a carrier-specific ongoing per-quarter IT-synchronization maintenance cost. You may terminate IT synchronization with a plant-to-DC carrier at any time at no cost. If you subsequently decide to reestablish IT synchronization, the one-time setup cost would again accrue in the initial quarter of IT synchronization with any plant-to-DC carrier.
2. **Delivery Performance Improvement**: IT-synchronization linkages improve surface transportation delivery performance for plant-to-DC carriers. With greater delivery reliability, the relative attractiveness of surface transport compared to air transport obviously improves.

Table below details these specifics for each plant-to-DC carrier. Your firm may establish and maintain IT synchronization with one or more plant-to-DC carriers with these costs and benefits.

**Decision options associated with each plant-to-DC carrier are as follows:**

* **Decision Option "0"**: Do not have IT synchronization.
* **Decision Option "1"**: Establish and maintain IT synchronization with costs and other ramifications as described above.

Note that these options are carrier-specific. A separate IT-synchronization decision is required for each of the six available plant-to-DC carriers, carriers I to N.

**Exhibit 12: IT Synchronization with Carriers, Costs and Benefits**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Plant-To-DC Carriers | I | J | K | L | M | N |
| One-Time Setup Cost | $9K | $8K | $9K | $9K | $6K | $5K |
| Quarterly Maintenance Cost | $7K | $7K | $9K | $8K | $6K | $3K |
| Surface Transportation Change | +5% | +10% | +6% | +3% | +4% | +2% |

## IT Synchronization with Sub-Assembly Component Suppliers

You may establish vendor-managed inventory systems with your sub-assembly component suppliers. By linking your IT system with the IT systems of one or more of your suppliers, an enhanced degree of supply chain synchronization is achieved in procurement, with corresponding improvements in surface transportation delivery performance and component quality (i.e., a reduction in sub-assembly component failure rates).

The specifics of supplier IT synchronization within FLEX are as follows:

1. **Setup and Maintenance Costs**: IT synchronization involves a one-time cost per supplier to implement initially and a supplier-specific ongoing per-quarter maintenance cost. You may terminate IT synchronization with a sub-assembly component supplier at any time at no cost. If you subsequently decide to reestablish IT synchronization, the one-time setup cost would again accrue in the initial quarter of IT synchronization with any sub-assembly component supplier.
2. **Delivery Performance Improvement**: IT-synchronization linkages improve surface transportation delivery performance for sub-assembly component suppliers. With greater delivery reliability, the relative attractiveness of surface transport compared to air transport obviously improves.
3. **Quality Improvement**: An IT-synchronization linkage improves the failure rate of a supplier's sub-assembly components. Failure rates decrease based on closer synchronization between buyer (your firm) and the sub-assembly component supplier.

Table below details these specifics for each sub-assembly component supplier. Your firm may establish and maintain IT synchronization with one or more sub-assembly component suppliers with these costs and benefits.

**Decision options associated with each sub-assembly component supplier are as follows:**

* **Decision Option "0"**: Do not have IT synchronization.
* **Decision Option "1"**: Establish and maintain IT synchronization with costs and other ramifications as described above.

Note that these options are supplier specific. A separate IT-synchronization decision is required for each of the seven available sub-assembly component suppliers, suppliers A to G.

## IT Synchronization with Suppliers, Costs and Benefits

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sub-Assembly Component Supplier | A | B | C | D | E | F | G |
| One-Time Setup Cost | $9K | $8K | $9K | $9K | $6K | $7K | $7K |
| Quarterly Maintenance Cost | $7K | $7K | $9K | $8K | $6K | $5K | $5K |
| Surface Transportation Change | +5% | +4% | +6% | +3% | +4% | +5% | +6% |
| Failure Rate Change | -0.2% | -0.1% | -0.4% | -0.5% | -0.4% | -0.3% | -0.3% |

# Chapter 11: Financial Reports

Understanding and tracking your firm's financial and operational metrics is crucial for effective management and decision-making in the FLEX simulation.

## Key Financial Reports

### Corporate P&L Statement

The Corporate P&L Statement aggregates all product-specific profit-and-loss statements into an overall corporate profit-and-loss statement. A variety of line items appear on the Corporate P&L Statement only, because it is not possible to unambiguously allocate those costs to specific products in specific regions for specific channels.

Definitions of non-obvious line items on the Corporate P&L Statement follow:

* **Administrative Overhead ("Administrative O/H")**: $80,000/quarter and $120,000/quarter per product in channels 1 and 2, respectively, in all market regions.
* **Consulting Fees**: Adjustments to income or expenses.
* **Corporate Overhead ("Corporate O/H")**: $250,000 per product per quarter.
* **Distribution FC**: Fixed costs associated with operating distribution centers.
* **Duties & Tariffs**: A percentage of the average selling price for finished goods imported into any market region.
* **Emergency Procurement**: All emergency procurement costs.
* **Emergency Production**: All emergency production costs, including standby emergency production charges plus any actual emergency-related excess costs.
* **Forecast Inaccuracy**: Costs associated with forecasting errors.
* **Information Technology**: All IT charges.
* **Introductions**: Costs when products are introduced into market regions or channels.
* **Inventory Charges**: Costs related to storage, handling, waste, and insurance.
* **Marketing**: Total marketing spending.
* **Non-Operating Income**: Interest earned on Marketable Securities or interest paid on Loans.
* **Operating Income**: Gross Margin minus Total Fixed Costs.
* **Patent Royalties**: Royalties paid to other firms and received from other firms.
* **Plant Capacity FC**: Costs associated with production shifts in your manufacturing plant.
* **Procurement FC**: Fixed costs associated with procurement.
* **Production FC**: Fixed costs associated with production orders.
* **Service Salaries**: Total salary cost associated with service centers.
* **Service Overhead ("Service O/H")**: Service center overhead cost.
* **Service Hire & Fire**: Service center hiring and firing costs.
* **Unfilled Handling**: Unfilled orders handling costs.
* **Taxes**: Corporate taxes payable in the market region where your firm has its manufacturing plant.
* **Total Fixed & Other**: Sum of all fixed costs.
* **Transportation Rebates**: Sum of rebates on plant-to-DC shipments if a single carrier is used exclusively.

### Product P&L Statement

Each product has a current profit-and-loss statement each quarter. The product P&L Statement includes the relevant data for all channels.

## Balance Sheet

Your balance sheet records the usual assets and liabilities associated with your firm at the end of each quarter. Among other things, current levels of procurement and finished goods inventories are reported on the balance sheet.

On the Balance Sheet:

* **Cash**: Represents your cash balance.
* **Corporate Capitalization**: The dollar value of the original capital invested by your shareholders.
* **Dividends**: Cash payments to shareholders.
* **Plant Investment**: The dollar value of your firm's investment in a manufacturing plant.
* **On-order Motherboard Sub-assembly Components**: Components ordered for delivery next quarter.

## Cash Flow Analysis Report

The Cash Flow Analysis Report details the sources and uses of cash within your firm. Key aspects include:

* **Cash Sources**: Profits from operations and reductions in inventory holdings.
* **Cash Uses**: Funding operating losses, increases in inventory holdings, and payment of dividends.
* **Loans**: Issued automatically to cover cash shortfalls, with interest paid on loans.

## Additional Reports (Supplementary Notes)

For more detailed insights, several additional reports are available as supplementary notes:

* **Finished Goods Inventory Report**: Details of your finished goods inventories.
* **Procurement Inventory Report**: Procurement inventories by distribution center.
* **Forecasting Accuracy Report**: Details of forecasting accuracy for sales volume forecasts.
* **Service Center Operations Reports**: Call volumes at your regional service centers.
* **Other Decision Variables Report**: Listing of current values of procurement, manufacturing, transportation, and IT decision variables.
* **Products Industry Bulletin**: Current-quarter industry-related information.

# Chapter 12: Performance Evaluation

Since there are many facets of evaluation to consider in a business, a multi-dimensional quantitative performance evaluation scorecard is used in FLEX. Current performance and change in performance are considered in this multi-dimensional quantitative performance evaluation scorecard.

The FLEX scorecard is perhaps described more aptly as a boardroom-level scorecard. It focuses on top-line boardroom kinds of financial, operational, customer, and external performance measures and sub-measures.

The FLEX scorecard is based on a ranking of performance on each sub-measure. These rank-order comparisons across all competing firms within your industry avoid the undue influence of particularly extreme values of individual sub-measures. This FLEX scorecard is a within-industry performance evaluation system. Comparisons across industries are problematic due to variations in environmental and competitive milieu.

The FLEX scorecard includes the following financial, operational, customer, and external measures:

* **Financial Measures:**
  + Net Profit Margin
  + Operating Margin
  + Inventory Turns
  + Sales Growth
* **Operational Measures:**
  + Inventory Turnover
  + Fill Rate
  + Production Deviation
  + Defect Rate
  + Controllable Procurement and Manufacturing Costs to Revenue
  + Transportation Expenses per Unit Sold
  + Forecast Accuracy
* **Customer Measures:**
  + Market Penetration Rate
  + Customer Satisfaction Index (CSI)
  + External Measures:
  + Revenue Growth
  + Earnings Growth
  + Consistency Score (0,1)

This chapter describes the recommended FLEX quantitative performance evaluation mechanism. Since there are many facets of evaluation to consider in a business, a multi-dimensional scorecard is used. As you’ll note, current performance and change in performance are considered in this multi-dimensional quantitative performance evaluation scorecard.

Many things matter in evaluating the performance of a business. It's hard to argue with profitability-like measures as the correct things to examine to assess the long-run performance of a business. However, in a shorter-run perspective, other things matter too. These "other things" are leading indicators of future profitability and root causes of profitability.

Multiple measures of performance evaluation obviously lead to conflicts. Short-run and long-run trade-offs are obvious. For example, by reducing inventories and product support spending (marketing and service spending), current costs will decrease, and profits will tend to increase. However, in the long run, these might be exactly the wrong things to do to maximize long-run profitability. Subtler trade-offs arise in potentially conflicting performance measures that move in opposite directions. For example, inventory reductions save costs on the inventory and manufacturing fronts but may lead to shortages to meet the levels of customer demand in the distribution centers. Balancing all of these conflicting trade-offs is the challenge for management.

The various performance measures within FLEX are designed to monitor all key elements of performance assessment: efficiency (input usage); effectiveness (output quality); productivity (conversion of inputs into output); firm-wide profitability; and external performance (e.g., change in market share and customer satisfaction perceptions).

## The FLEX Scorecard

The FLEX scorecard is perhaps described more aptly as a boardroom-level scorecard. It focuses on top-line boardroom kinds of financial, operational, customer, and external performance measures and sub-measures. The FLEX scorecard includes the measures and weights described in Exhibits 19-22. Each firm in your products industry submits their raw data to the Products Trade Association, which provides your firm's personal scorecard every quarter.

The FLEX scorecard is based on a ranking of performance on each sub-measure. These rank-order comparisons across all competing firms within your industry avoid the undue influence of particularly extreme values of individual sub-measures. This FLEX scorecard is a within-industry performance evaluation system. Comparisons across industries are problematic due to variations in environmental and competitive milieu.

Your firm receives weighted points for each competitor for whom your performance on a sub-measure is better. For some of the sub-measures, "better" means a lower sub-measure value (e.g., the "Controllable Procurement and Manufacturing Costs to Revenue" is a lower-is-better sub-measure). For example, if your firm's ratio of "Net Profits" to "Revenues" is better than three other firms' ratios, your firm receives 9 points. (Of course, the top-performing firm on "Net Income" to "Revenues" ratio in a 6-firm industry would receive 15 points.) In general, the maximum available points on any sub-measure are W(N-1) where "W" is the sub-measure's weight and "N" is the number of firms in the industry. Points accumulate each quarter throughout the FLEX exercise.

To avoid an overemphasis on minor quarter-to-quarter variations in the calculation of the ranking of firms on the performance sub-measures in the FLEX scorecard, minor differences in the sub-measures are treated as ties in the calculation of ranking points. The thresholds for differences to be treated as meaningful are listed in Exhibits 19-22 for each sub-measure. For example, differences of 0.2% or less for "Net Profit Margin" are considered to be statistically insignificant, and firms within 0.2% of each other would be treated as being tied. Thus, two firms with ratios of Net Income to Revenues of 4.5% and 4.6% would be treated as being tied in the calculation of ranking position and associated points received in any quarter.

A sample FLEX scorecard is shown in Exhibit 22. You receive this scorecard automatically each quarter as the first page of your financial and operating reports. This scorecard provides comparatives to assess how your firm's data compares to the industry averages and industry bests on every KPI. You can assess where your firm stands compared to competitors with this scorecard.

## Exhibit 19: Scorecard Financial Measures

|  |  |  |
| --- | --- | --- |
| Sub-Measures | Weight | Sub-Measure Details |
| Net Profit Margin | 3 | Current profitability is the best overall signal of business performance, hence its high weight. Firms are "tied" if their scores are within 0.2% of each other. |
| Operating Margin | 1 | Improvement in profitability is important but less important than current profitability. Firms are "tied" if their scores are within 0.2% of each other. |
| Inventory Turns | 2 | Return means "Net Income" (from the "Corporate P&L Statement") and investment equals "Total Assets" (from the "Balance Sheet"). This ratio is expressed in annualized terms. Firms are "tied" if their scores are within 0.5% of each other. |
| Sales Growth | 1 | Ratio of revenues to net assets. Net assets are assets minus loans. This measure reflects the desirability of higher revenues relative to the assets deployed to yield these revenues. This ratio is expressed in annualized terms. Firms are "tied" if their scores are within 0.2 of each other. |

Notes: Positive "weights" are associated with sub-measures where "more is better" and negative "weights" are associated with sub-measures where "less is better." "Change" measures are based on quarter-to-quarter changes.

## Exhibit 20: Scorecard Operational Measures

|  |  |  |
| --- | --- | --- |
| Sub-Measures | Weight | Sub-Measure Details |
| Inventory Turnover | 2 | Ratio of product costs to average inventory value (average of the current and the previous quarters). If average inventory value is zero, then Inventory Turnover is defined to be 100. Firms are "tied" if their scores are within 0.2 of each other. |
| Fill Rate | 1 | The percentage of orders that are filled. "Unfilled orders" occur when available inventory and emergency production is less than orders in a quarter. Firms are "tied" if their scores are within 0.5% of each other. |
| Production Deviation | -1 | The percentage of total production (postponed, regular, and emergency) that is emergency production. Firms are "tied" if their scores are within 0.5% of each other. |
| Defect Rate | -1 | Ratio of replacement parts demand to sales volume (orders). Firms are "tied" if their scores are within 0.5% of each other. |
| Controllable Procurement and Manufacturing Costs to Revenue | -1 | Controllable procurement and manufacturing costs include "Disposal Sales," "Emergency Procurement," "Emergency Production," "Inventory Charges," "Procurement FC," and "Production FC." Firms are "tied" if their scores are within 0.2% of each other. |
| Transportation Expenses per Unit Sold | -1 | Equal to total transportation costs divided by total units sold (orders). Firms are "tied" if their scores are within 0.5 of each other. |
| Forecast Accuracy | 2 | Forecasting accuracy is a relatively pure signal of management skill and expertise (in this case, in the area of understanding customers and customer demand generating forces). Firms are "tied" if their scores are within 0.5% of each other. |

Notes: Positive "weights" are associated with sub-measures where "more is better" and negative "weights" are associated with sub-measures where "less is better." "Change" measures are based on quarter-to-quarter changes.

## Exhibit 21: Scorecard Customer Measures

|  |  |  |
| --- | --- | --- |
| Sub-Measures | Weight | Sub-Measure Details |
| Market Penetration Rate | 1 | Measures the extent to which a product is known and used by customers in a market. Firms are "tied" if their scores are within 0.1% of each other. |
| Customer Satisfaction Index (CSI) | 2 | Measures the performance of the product from the perspective of purchasers. Thus, it's a clear measure of customer performance and a long-run leading indicator of repeat purchasing behavior and customer retention. Average customer satisfaction across all products, channels, and regions is used here. Firms are "tied" if their scores are within 0.5% of each other. |

## External Measures: Financial Investors' Perspective

The external measure in the FLEX scorecard is designed to provide a comprehensive view of the firm's attractiveness to potential financial investors. This measure is constructed as an index based on three critical metrics: Revenue Growth, Earnings Growth, and Consistency of Growth over recent quarters. The FI Index helps investors assess the stability and growth potential of the firm, guiding investment decisions.

**Metrics Used in the FI Index:**

1. **Revenue Growth:**

* This metric reflects the percentage increase in the firm's revenue over a specified period.
* The index assigns scores as follows:
  + - 1-10% growth: Score = 1
    - 10-20% growth: Score = 2
    - 20-30% growth: Score = 3
    - Above 30% growth: Score = 4

1. **Earnings Growth:**

* This metric captures the percentage increase in the firm's earnings over a specified period.
* The index assigns scores as follows:
  + - 1-20% growth: Score = 1
    - 20-30% growth: Score = 2
    - Above 30% growth: Score = 3

1. **Consistency of Growth:**

* This binary metric evaluates whether the firm's earnings have consistently increased over the last five quarters.
* The index assigns scores as follows:
  + - Consistent earnings growth over the last 5 quarters: Score = 1
    - Inconsistent earnings growth over the last 5 quarters: Score = 0

**Calculating the FI Index:**

* The FI Index is calculated by summing the scores from the three metrics.
* The possible range of the FI Index is 2 to 8.

**Interpretation:**

* A higher FI Index indicates a firm with strong and consistent growth, making it more attractive to investors.
* The FI Index allows for easy comparison of firms within the same industry, facilitating informed investment decisions.

**Example:**

* **Firm A:**
  + Revenue Growth: 25% (Score = 3)
  + Earnings Growth: 15% (Score = 1)
  + Consistency of Growth: Yes (Score = 1)
  + FI Index = 3 + 1 + 1 = 5
* **Firm B:**
* Revenue Growth: 35% (Score = 4)
* Earnings Growth: 25% (Score = 2)
* Consistency of Growth: No (Score = 0)
* FI Index = 4 + 2 + 0 = 6

In the FLEX scorecard, the FI Index is visualized in a comparative graph, displaying the index scores of all firms in the industry. This graphical representation aids in quickly identifying firms with superior growth characteristics, providing a clear overview of their relative investment attractiveness.

# Glossary

1. **FLEX Simulation:** A comprehensive tool that simulates the management of supply chain operations, allowing users to make strategic decisions in a controlled environment.
2. **Supply Chain:** The network of suppliers, manufacturers, warehouses, distribution centers, and retailers that work together to produce and deliver products to consumers.
3. **Production Strategy:** The approach a company takes to manufacturing goods, focusing on factors such as cost efficiency, quality control, and time management.
4. **Manufacturing Environment:** The physical and operational setting in which products are produced, including factories, machinery, workers, and workflows.
5. **Postponed Production:** A manufacturing strategy where the final assembly of products is delayed until there is a confirmed demand, minimizing inventory costs and improving responsiveness to customer needs.
6. **Consumer Electronics Industry:** A sector focused on creating electronic devices intended for everyday use by consumers, including products like smartphones, laptops, and smart home devices.
7. **Smart Home Assistant (SHA):** An electronic device that helps users manage various home functions, such as lighting, temperature, and security, through voice commands or apps.
8. **Smart Thermostat (ST):** A device used to control the heating and cooling systems in homes or offices, often programmable and sometimes connected to the internet for remote control.
9. **Subassemblies:** Components that are pre-assembled as part of a larger product, such as a car engine or computer motherboard, before being integrated into the final product.
10. **Raw Materials:** The basic materials used to create products, such as metals, plastics, and chemicals, often sourced from suppliers before being processed in manufacturing.
11. **Procurement:** The process of acquiring raw materials, parts, and services from external suppliers to be used in the production process.
12. **Inventory Management:** The oversight of storing and managing the flow of raw materials, work-in-progress, and finished goods to ensure that production runs smoothly and customer orders are fulfilled.
13. **Distribution:** The activities involved in moving products from the manufacturing site to the end customer, including warehousing, transportation, and logistics.
14. **Information Flows:** The movement and exchange of information within the supply chain, enabling coordination and decision-making across different stages of production and distribution.
15. **Fact-Based Analysis:** Decision-making that relies on empirical data and statistical evidence rather than intuition or speculation.
16. **Financial Statements:** Reports that provide an overview of a company's financial performance, including income, expenses, profits, assets, and liabilities.
17. **Profit and Loss Statement (P&L):** A financial report that summarizes the revenues, costs, and profits or losses over a specified period, often used to assess a company’s profitability.
18. **Balance Sheet:** A financial statement that provides a snapshot of a company's assets, liabilities, and shareholders' equity at a specific point in time, indicating the company’s financial position.
19. **Cash Flow Statement:** A report detailing the inflows and outflows of cash within a company during a given period, showing how well the company generates cash to fund its operations and growth.
20. **Emergency Procurement:** The process of urgently acquiring raw materials or components when regular inventory levels are insufficient to meet production needs, often at a higher cost.
21. **Sub-Assembly Components:** Parts that are assembled into larger components before being integrated into the final product, such as a circuit board in a smartphone.
22. **Warranty Costs:** Expenses incurred by a company to cover repairs or replacements of products during a specified warranty period.
23. **Surface Shipping:** Transportation of goods via land or sea, typically slower and less expensive than air shipping but with varying reliability.
24. **Emergency Production:** The rapid production of goods to meet unexpected demand or fill gaps in inventory, often at a higher cost due to the urgency.
25. **Distribution Center (DC):** A warehouse facility where products are stored before being distributed to retailers or customers. DCs play a critical role in managing inventory and fulfilling orders.
26. **Cross-Docking:** A logistics strategy where incoming shipments are directly transferred to outbound vehicles, reducing the need for storage and speeding up the distribution process.
27. **RFID (Radio-Frequency Identification):** A technology that uses electromagnetic fields to automatically identify and track tags attached to objects, commonly used in inventory management.
28. **Forecasting:** The process of estimating future demand, sales, and other key business metrics to guide decision-making in procurement, production, and distribution.
29. **Vendor-Managed Inventory (VMI):** A system where the supplier manages the inventory levels of their products at the customer’s location, improving supply chain efficiency and reducing stockouts.
30. **IT Synchronization:** The alignment and integration of IT systems between a company and its supply chain partners to improve data accuracy, communication, and overall efficiency.
31. **Service Outsourcing:** Contracting external companies to manage certain business functions, such as customer service or IT support, to leverage external expertise and reduce operational costs.
32. **Demand Management:** The process of balancing customer demand with supply chain capabilities, including forecasting, pricing, and marketing strategies.
33. **Price Sensitivity:** The degree to which changes in price affect consumer demand for a product, influencing pricing strategies.
34. **Channel Decisions:** Choices related to which sales channels to use for distributing products, such as retail stores, online platforms, or direct sales.
35. **Marketing Spending:** The allocation of budget for advertising, promotions, and other marketing activities aimed at increasing brand awareness and driving sales.
36. **Forecast Accuracy:** The degree to which predictions about future sales and demand match actual outcomes, crucial for efficient inventory and production planning.
37. **Performance Evaluation:** The assessment of a company’s effectiveness using various metrics, including financial performance, operational efficiency, and customer satisfaction.
38. **Net Profit Margin:** A financial ratio that shows the percentage of revenue left after all expenses have been deducted, indicating the profitability of a company.
39. **Operating Margin:** A profitability ratio that measures the percentage of revenue remaining after covering operating expenses, showing how efficiently a company is being managed.
40. **Inventory Turns:** A metric that indicates how often inventory is sold and replaced over a certain period, reflecting the efficiency of inventory management.
41. **Sales Growth:** The increase in a company's sales revenue over time, often used as a key indicator of business expansion and market demand.
42. **Fill Rate:** The percentage of customer orders that are fulfilled from available stock, a key measure of inventory management effectiveness.
43. **Defect Rate:** The percentage of products that fail to meet quality standards and require replacement or repair, affecting customer satisfaction and warranty costs.
44. **Transportation Expenses:** Costs associated with moving goods through the supply chain, including shipping, fuel, and logistics management.
45. **Customer Satisfaction Index (CSI):** A measure of how satisfied customers are with a company’s products or services, often influencing repeat business and brand loyalty.
46. **Revenue Growth:** The increase in a company’s sales revenue over a specified period, indicating the company’s ability to grow its market share and profitability.
47. **Earnings Growth:** The increase in a company’s profit over time, reflecting its financial health and operational success.
48. **Consistency Score:** A measure of how consistently a company has maintained growth in key financial metrics, such as earnings and revenue, over time.
49. **Enterprise Integration:** The coordination of processes and systems across different parts of a company to improve efficiency and collaboration, often involving IT and data management systems.
50. **Sales Channel:** A route through which a product reaches the end consumer, such as retail stores, online platforms, or direct sales.
51. **Order Processing:** The series of actions required to fulfill a customer’s order, from receiving the order to delivering the product.
52. **Direct Channel:** A sales strategy where products are sold directly to consumers without intermediaries, often through online platforms.
53. **Retail Channel:** A sales strategy where products are sold through physical stores or other retail outlets.
54. **Marketing Spillover:** The effect of marketing activities in one channel or region on consumer behavior in another, often leading to cross-channel or cross-region sales.
55. **Inventory Charges:** Costs associated with storing, handling, and managing inventory, including warehousing and insurance expenses.
56. **Consulting Fees:** Payments made to external experts for advice and services, often related to strategic decisions or specialized knowledge areas.
57. **Corporate Overhead:** The ongoing costs of operating a business that are not directly tied to the production of goods, such as administrative expenses and executive salaries.
58. **Distribution FC (Fixed Costs):** Costs that do not change with the level of goods produced or sold, specifically related to operating distribution centers.
59. **Duties & Tariffs:** Taxes imposed on goods when they are imported into a country, affecting the cost of goods sold in international markets.
60. **Operating Income:** The profit earned from a company’s core business operations, calculated as revenue minus operating expenses.
61. **Plant Capacity FC (Fixed Costs):** The fixed expenses associated with maintaining the capacity of a manufacturing plant, including depreciation and maintenance.
62. **Procurement FC (Fixed Costs):** Fixed costs related to the procurement of materials and components, including setup and ongoing supplier relationship management.
63. **Service Salaries:** The total salary costs for employees working in service roles, such as customer support and technical assistance.
64. **Service Overhead (Service O/H):** The indirect costs associated with running a service operation, including utilities, equipment, and management expenses.
65. **Unfilled Handling:** Costs associated with managing unfulfilled customer orders, which may include communication, refunds, or compensatory actions.
66. **Taxes:** Compulsory financial charges imposed by governments on a company’s income, property, or transactions.
67. **Transportation Rebates:** Discounts or financial incentives offered by carriers for using their transportation services exclusively or in large volumes.
68. **Cash Flow Analysis Report:** A detailed report that tracks the sources and uses of cash within a company, helping to manage liquidity and financial planning.
69. **Finished Goods Inventory Report:** A document that provides detailed information on the quantities and locations of finished products ready for sale.
70. **Procurement Inventory Report:** A report that details the inventory levels of raw materials and components at different stages of the supply chain.
71. **Forecasting Accuracy Report:** A report that evaluates the accuracy of sales and demand forecasts, helping to refine future predictions and reduce forecasting errors.
72. **Service Center Operations Reports:** Reports that provide insights into the performance of service centers, including call volumes, response times, and customer satisfaction.
73. **Product P&L Statement:** A profit and loss statement specific to a single product, showing the financial performance of that product within the company.
74. **Administrative Overhead:** General expenses required to manage and support the operations of a company, including salaries of non-production staff, office supplies, and utilities.
75. **Gross Margin:** The difference between revenue and the cost of goods sold, expressed as a percentage of revenue, indicating how much profit is made before deducting overhead and operating expenses.
76. **Market Penetration Rate:** The percentage of potential customers in a market who have purchased a company’s product, used as a measure of market share.
77. **Forecast Inaccuracy:** The costs incurred due to discrepancies between forecasted and actual sales, often leading to increased administrative overhead and inventory imbalances.
78. **Service Quality Guarantees (SQ Guarantees):** Long-term averages that service providers promise to maintain in terms of performance metrics like customer satisfaction or response times.
79. **Sales Volume Forecasts:** Estimates of the quantity of products that will be sold in a future period, crucial for planning production and inventory levels.
80. **On-Order Inventory:** Items that have been ordered from suppliers but have not yet been received, often listed on the balance sheet as a current asset.
81. **Customer Shipment Transportation Costs:** Expenses incurred in delivering products to customers, including shipping, handling, and any associated fees.
82. **Inbound Transportation:** The movement of raw materials or components from suppliers to a company’s manufacturing facilities.
83. **Outbound Transportation:** The process of shipping finished goods from manufacturing facilities to distribution centers or customers.
84. **Shipment Volume Decisions:** Choices regarding the quantity of goods to be transported in a given period, influencing transportation costs and inventory levels.
85. **Transportation Mode Choice:** The selection of a method for transporting goods, such as air, sea, or land, based on factors like cost, speed, and reliability.
86. **Plant Investment:** The capital expenditure made by a company to build, upgrade, or maintain its manufacturing facilities.
87. **Corporate Capitalization:** The total value of a company's equity and debt, representing the financial resources available to the business.
88. **Dividends:** Payments made to shareholders from a company’s profits, typically on a quarterly or annual basis.
89. **Marketable Securities:** Financial instruments that can be quickly converted into cash, often held as short-term investments by a company.
90. **Loans:** Borrowed funds that a company must repay with interest, often used to finance operations or capital expenditures.
91. **Fixed Costs:** Expenses that do not vary with the level of production or sales, such as rent, salaries, and insurance.
92. **Variable Costs:** Costs that change in direct proportion to the level of production, such as raw materials, direct labor, and utilities.
93. **Consulting Fees:** Payments made to external experts for advice or specialized services, often related to strategic or technical areas.
94. **Plant Capacity:** The maximum output that a manufacturing plant can produce in a given period, influenced by factors like equipment, labor, and space.
95. **Depreciation:** The gradual reduction in the value of a fixed asset over time, often due to wear and tear, age, or obsolescence.
96. **Safety Stock:** Additional inventory kept on hand to mitigate the risk of stockouts due to demand variability or supply chain disruptions.
97. **Economic Order Quantity (EOQ):** The optimal order quantity that minimizes the total costs of ordering and holding inventory.
98. **Lead Time:** The time it takes from placing an order with a supplier until the goods are received and ready for use.
99. **Just-In-Time (JIT):** An inventory management strategy where materials are ordered and received just before they are needed in the production process, minimizing inventory levels.
100. **Total Quality Management (TQM):** A management approach focused on continuous improvement in all aspects of a business, with the goal of enhancing product quality and customer satisfaction.
101. **Six Sigma:** A set of techniques and tools for process improvement aimed at reducing defects and improving quality in manufacturing and business processes.
102. **Key Performance Indicators (KPIs):** Quantifiable measures used to evaluate the success of an organization in achieving its objectives.
103. **Earnings Before Interest and Taxes (EBIT):** A measure of a company’s profitability that excludes interest and income tax expenses, giving insight into its operational efficiency.
104. **Return on Assets (ROA):** A financial ratio that shows how profitable a company is relative to its total assets, indicating how efficiently management is using its assets to generate earnings.
105. **Return on Equity (ROE):** A measure of financial performance calculated by dividing net income by shareholders' equity, indicating how well the company is using equity to generate profit.
106. **Debt-to-Equity Ratio:** A financial ratio indicating the relative proportion of shareholders' equity and debt used to finance a company's assets.
107. **Working Capital:** The difference between a company’s current assets and current liabilities, indicating its short-term financial health and ability to cover its obligations.
108. **Inventory Turnover Ratio:** A measure of how many times inventory is sold and replaced over a specific period, indicating the efficiency of inventory management.
109. **Break-Even Analysis:** A calculation that determines the level of sales needed to cover all fixed and variable costs, showing when a business will start to make a profit.
110. **Cost of Goods Sold (COGS):** The direct costs attributable to the production of the goods sold by a company, including raw materials and direct labor.
111. **Gross Profit:** The difference between sales revenue and the cost of goods sold, indicating the profit made before deducting operating expenses.
112. **Net Income:** The total profit of a company after all expenses, including taxes and interest, have been deducted from revenue.
113. **Supply Chain Risk Management:** The process of identifying, assessing, and mitigating risks within the supply chain to ensure continuity and minimize disruptions.
114. **Capacity Planning:** The process of determining the production capacity needed by an organization to meet changing demands for its products.
115. **Material Requirements Planning (MRP):** A system for calculating the materials and components needed to manufacture a product, ensuring that inventory levels are sufficient to meet production schedules.
116. **Supply Chain Visibility:** The ability to track and monitor the status of products and materials throughout the supply chain, enhancing decision-making and responsiveness.
117. **Total Cost of Ownership (TCO):** The total cost of purchasing and operating an asset over its entire lifecycle, including acquisition, operation, maintenance, and disposal costs.
118. **Outsourcing:** The practice of hiring external organizations to perform business processes or provide services that could be performed in-house, often to reduce costs or improve efficiency.
119. **Lean Manufacturing:** A production methodology aimed at minimizing waste and maximizing value in the manufacturing process by improving efficiency and reducing unnecessary steps.
120. **Supplier Relationship Management (SRM):** The practice of strategically managing interactions and relationships with suppliers to optimize the value of those relationships.
121. **Demand Forecasting:** The process of predicting future customer demand for products or services based on historical data, market trends, and other factors.
122. **Lead Time Demand:** The amount of inventory that will be consumed during the lead time, used to determine reorder points and safety stock levels.
123. **Reorder Point (ROP):** The inventory level at which a new order should be placed to replenish stock before it runs out, calculated based on lead time demand and safety stock.
124. **Economic Order Quantity (EOQ): The** optimal order quantity that minimizes the total costs of ordering and holding inventory.
125. **Inventory Carrying Costs:** The total cost of holding inventory, including storage, insurance, taxes, and opportunity costs.
126. **Backorder:** An order for a product that is temporarily out of stock and will be fulfilled when the product becomes available.
127. **Obsolete Inventory:** Inventory that is no longer usable or saleable due to age, damage, or changes in demand, often leading to write-offs or disposal.
128. **Reverse Logistics:** The process of moving goods from customers back to the manufacturer or supplier for returns, repairs, recycling, or disposal.
129. **Supplier Lead Time:** The time it takes for a supplier to deliver goods after an order has been placed, influencing inventory planning and order timing.
130. **Purchase Order (PO):** A formal document issued by a buyer to a supplier, detailing the types, quantities, and agreed prices for products or services to be delivered.
131. **Order Lead Time:** The time between placing an order and receiving the goods, critical for inventory management and production planning.
132. **Supply Chain Integration:** The coordination and alignment of supply chain processes and information systems across all stages of production and distribution.
133. **Capacity Utilization:** The extent to which a company uses its production capacity, expressed as a percentage of total potential output.
134. **Demand Variability:** The fluctuations in customer demand over time, which can complicate inventory management and production scheduling.
135. **Production Schedule:** A plan that outlines when and how much of each product will be manufactured, helping to align production with demand forecasts.