**Stakeholders, Customers and Financial Measures**

* Identifying stakeholders and using Balanced Scorecard to balance the needs of all stakeholders
* Voice of the customer
  + Identify customer
  + Collect and analyze customer data
    - Data Types
    - Important data collection techniques (Surveys, Focus Groups, Interviews and Observation)
  + Determine critical requirements
    - Kano Model : Determining product attributes important for customers
    - Quality Function Deployment
* Benchmarking
* Important process performance metrics – Six Sigma
* Financial Measures for Six Sigma – NPV, PV, IRR, Payback Period, Life Cycle Cost, BCR, Opportunity Cost, Sunk cost

**1. Stakeholders**

Stakeholders are **individuals or groups** who have an **interest in the process or its outcome**. They can influence or be affected by a Lean Six Sigma project.

**🔹 Types of Stakeholders:**

* **Internal**: Employees, management, executives, departments
* **External**: Customers, suppliers, regulators, shareholders

**🔹 Why They Matter:**

* Stakeholders provide input on **what "success" looks like**
* Their **buy-in** is critical for project approval and implementation
* Must be kept **informed and engaged** throughout the DMAIC process

**2. Customers**

In Lean Six Sigma, the **customer is central**—everything is driven by the goal of delivering **value to the customer**.

**🔹 Types of Customers:**

* **External Customers**: End users, clients who buy the product/service
* **Internal Customers**: Employees or departments who rely on output from another part of the organization

**🔹 Voice of the Customer (VOC):**

* A structured process to **gather, analyze, and prioritize customer needs**
* VOC data can come from surveys, complaints, interviews, etc.

**🔹 Critical to Quality (CTQ):**

* Key measurable characteristics defined by the customer that determine quality
* Used to translate VOC into **quantitative project goals**

**3. Financial Measures**

One of the goals of Lean Six Sigma is to **quantify the financial benefit** of process improvements.

**🔹 Common Financial Metrics:**

* **Cost of Poor Quality (COPQ)**: Cost from defects, rework, delays
* **Return on Investment (ROI)**: Profitability of the improvement effort
* **Savings**: Reduction in operational or resource costs
* **Revenue Growth**: If improvements lead to increased sales or customer retention

**🔹 Why Financial Measures Matter:**

* Helps justify the **business case** for a project
* Quantifies the **value** delivered by improvement
* Aligns projects with **organizational goals**

**🔁 How They Interconnect in a Lean Six Sigma Project:**

| **Element** | **Role in LSS Project** |
| --- | --- |
| **Stakeholders** | Provide insight, support, and ensure alignment |
| **Customers** | Define what “value” and “quality” mean |
| **Financials** | Show impact and validate success of the initiative |

### **Balanced Scorecard – Balancing the Needs of All Stakeholders**

Balancing the needs of all stakeholders is essential for sustainable organizational success. Stakeholders often have **conflicting priorities**, and focusing too heavily on the needs of one group can negatively impact others.

For example:

* **Overemphasis on cost reduction** may lead to short-term profitability gains, but it can compromise product or service quality, ultimately affecting customer satisfaction and brand reputation.
* **Focusing solely on shareholder value** and short-term stock performance may cause an organization to neglect its long-term strategic goals, such as maintaining customer loyalty or innovating for future growth.

The **Balanced Scorecard** is a strategic management tool designed to address this challenge. It translates stakeholder needs and organizational strategy into **quantifiable performance metrics** across four key perspectives:

1. **Financial**
2. **Customer**
3. **Internal Processes**
4. **Learning and Growth**

By using the Balanced Scorecard, organizations can align goals across departments, ensure a holistic view of performance, and **prevent tunnel vision** that could harm long-term sustainability.

### 📘 What is the Balanced Scorecard?

Developed by **Kaplan and Norton**, the BSC looks beyond traditional financial metrics by incorporating **four key perspectives**:

| **Perspective** | **Focus Area** | **Stakeholders Involved** |
| --- | --- | --- |
| **Financial** | Profitability, cost control, ROI | Shareholders, investors |
| **Customer** | Satisfaction, retention, value | Customers |
| **Internal Processes** | Efficiency, quality, innovation | Employees, managers |
| **Learning & Growth** | Employee skills, knowledge, culture | Employees, organization |

### 🧩 Purpose of the Balanced Scorecard:

* **Balance short-term vs. long-term objectives**
* **Include non-financial measures** (e.g., customer satisfaction, employee development)
* **Align departments and teams** with the organization’s strategy
* **Monitor strategic performance** across different stakeholder needs

### 🔄 Balancing Stakeholder Needs – Examples:

| **Stakeholder** | **Need/Expectation** | **Balanced Scorecard Response** |
| --- | --- | --- |
| **Customers** | High-quality service, fair pricing | Measured through customer satisfaction & retention |
| **Employees** | Training, growth, good work culture | Tracked via learning & development metrics |
| **Shareholders** | Profit, sustainability | Reflected in financial KPIs like ROI, net margin |
| **Management** | Efficient processes, performance | Evaluated through internal process improvements |
| **Society/Regulators** | Compliance, sustainability | May be integrated into internal or customer measures |

### ✅ Example Balanced Scorecard in a Supply Chain Company:

| **Perspective** | **Objective** | **Metric** |
| --- | --- | --- |
| **Financial** | Reduce operating costs | Cost per order, logistics savings |
| **Customer** | Improve delivery reliability | On-time delivery rate, NPS |
| **Internal Process** | Streamline inventory management | Inventory turnover, cycle time |
| **Learning & Growth** | Upskill staff in analytics | Training hours, certification rate |

## 📊 **Balanced Scorecard – Balancing Needs of All Stakeholders (Continued)**

### 🔧 **Steps in Using the Balanced Scorecard**

The Balanced Scorecard process follows a **structured, top-down approach** rooted in the organization's **vision and strategy**. It ensures that strategic goals are broken down into measurable performance indicators aligned with stakeholder needs.

### **Step-by-Step Process:**

1. **Define Vision and Strategy**
   * The organization’s long-term goals and mission form the foundation of the Balanced Scorecard.
   * These guide all stakeholder-related metrics and improvement initiatives.
2. **Identify Stakeholders and Key Metrics**
   * For each stakeholder group (e.g., customers, shareholders, employees), define what **"success"** looks like.
   * Experienced **Black Belts and Master Black Belts** assist in selecting these **critical metrics**.
3. **Develop Dashboards**
   * Create dashboards to visualize and track metrics related to each stakeholder group.
   * Each dashboard contains **result measures (Y)** that reflect key outcomes.
4. **Determine Drivers (Xs)**
   * For every **Y (outcome)**, identify the **Xs (influencing factors or causes)** that drive it.
   * This reflects the **Y = f(X)** principle used in Lean Six Sigma.

### 📘 **Example: Customer Satisfaction**

* **High-Level Metric (Y):** Customer Satisfaction
* **Potential Drivers (Xs):**
  + Decrease in product defects
  + Improvement in customer service response time
  + Enhanced product quality
  + Strong brand recognition

Thus:

**Customer Satisfaction (Y) = f(Defects, Service, Quality, Branding)**

This approach is called **progressive elaboration**—starting with **high-level metrics (Ys)** and working downward into **detailed root causes (Xs)**.

# Balanced Scorecard – example of Progressive Elaboration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A diagram of a product  AI-generated content may be incorrect. | |  | | --- | | Y = f(X1 , X2)  i.e. improving customer satisfaction is a function of better quality  and lower cost | | Y1 = f(X11 , X12)  i.e. providing better quality is a function of manufacturing  better product and better customer service | | Y11 = f(X111  , X112)  i.e. manufacturing better product is a function of reducing  defects and providing additional features | |

**Here, we see an example of how a high level effect (i.e. Y – Improving customer  satisfaction) is progressively broken down till we reach the low level causes (e.g. reducing defects – X111)**

### **1. What is Progressive Elaboration?**

**Progressive Elaboration** refers to the process of continuously refining and detailing a plan or strategy as more information becomes available. In strategic planning (like Balanced Scorecard), it involves breaking down broad goals into specific, measurable, and actionable items.

### **3. Progressive Elaboration Example in the Context of a Balanced Scorecard**

Let’s take a high-level strategic goal:

**Improve Customer Satisfaction** (Y)

This is the **Customer Perspective** in the Balanced Scorecard.

We ask: What causes customer satisfaction to improve?

#### **Level 1: Y = f(X1, X2)**

**Y (Improve Customer Satisfaction)**  
is a function of:

* X1: **Better Quality Products/Services**
* X2: **Lower Cost to Customers**

This means if we want to increase customer satisfaction, we need to focus on improving quality and reducing costs.

#### **Level 2: Y1 = f(X11, X12)**

Let’s break down **X1 (Better Quality)**:

**Y1 (Better Quality)**  
is a function of:

* X11: **Superior Manufacturing**
* X12: **Excellent Customer Service**

So, improving quality depends on both how well the product is made and how well we support customers.

#### **Level 3: Y11 = f(X111, X112)**

Now, let’s go deeper into **X11 (Superior Manufacturing)**:

**Y11 (Superior Manufacturing)**  
is a function of:

* X111: **Reducing Product Defects**
* X112: **Adding Valuable Features**

Hence, the quality of manufacturing improves if defects are minimized and useful features are added.

### **4. Summary of the Causal Chain**

| **Level** | **Variable** | **Description** |
| --- | --- | --- |
| Top | Y | Improve Customer Satisfaction |
| Level 1 | X1, X2 | Better Quality and Lower Cost |
| Level 2 | X11, X12 | Superior Manufacturing and Customer Service |
| Level 3 | X111, X112 | Fewer Defects and Additional Features |

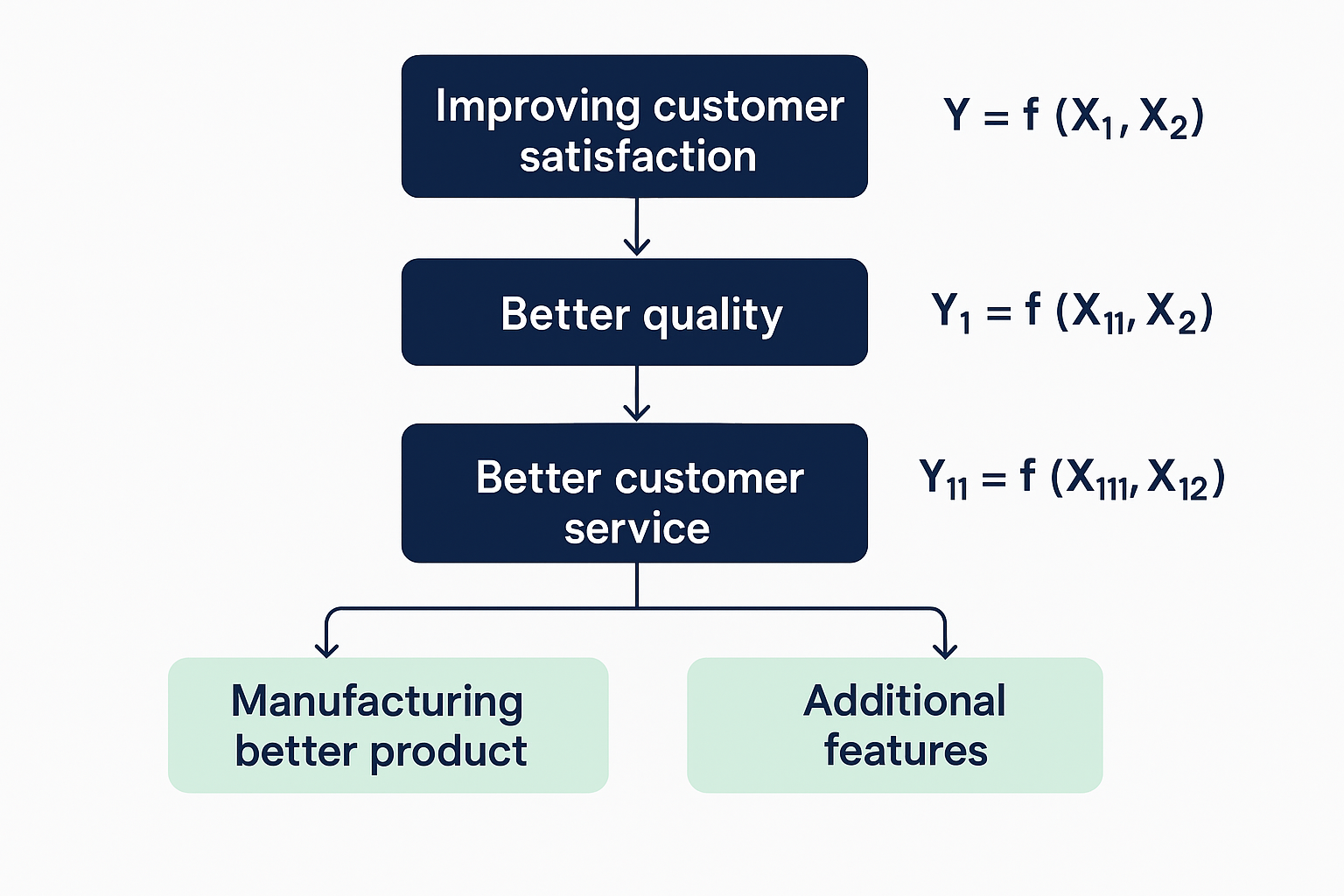
This hierarchy is an example of **progressive elaboration**—starting from a **strategic goal** and drilling down to **specific actions or root causes**.

### **5. Why is This Important?**

* It helps **align actions** at different levels of an organization.
* It provides a **clear roadmap** from strategy to execution.
* Each layer becomes a **measurable KPI or initiative**.
* Teams can focus on **what they can control** (e.g., reducing defects), while knowing it contributes to broader goals.

### **Conclusion**

Progressive elaboration in the Balanced Scorecard framework allows organizations to **decompose strategic goals** into smaller, manageable, and actionable components. This ensures **clarity**, **accountability**, and **alignment** across all levels of the business. It's a structured way of linking daily operations to high-level objectives like improving customer satisfaction.



# Benefits of Balanced Scorecard

* Very effective tool for getting inputs from different stakeholders, and ensuring that it aligns with the strategy and vision of the company.
* Helpful in project selection where inputs from all stakeholders ensure that no particular group gets undue advantage in the project selection process.
* Helps to quantify very high level objectives or results (i.e “Ys”) in terms of measurable effects (i.e. “Xs”), thus enabling management to make a more informed decision in the project selection process.

# Determining Critical Vital Xs

* When working with Six Sigma, our objective should be to find the critical effects which will have maximum impact on improving the objectives or results.
* In the balanced scorecard terminology we discussed earlier, the critical effects are also referred to as “Vital Xs” in the balanced scorecard. These are the effects which, if improved, will have a significant effect on the results i.e. the “Y variable.”

### **Determining Critical Vital Xs**

In Six Sigma, the goal is to **identify and improve the few key inputs (Xs)** that have the **most significant impact on the desired outcome (Y)**. These key inputs are referred to as **Vital Xs**.

#### ✅ Why Identify Vital Xs?

* Resources are limited — not all Xs are equally impactful.
* Focusing on Vital Xs ensures **maximum return on effort**.
* It supports **data-driven decision-making** rather than assumptions.

#### 🔍 Definition:

**Vital Xs** are the most influential process inputs or causes that significantly affect the desired output (Y).

#### 📊 In Balanced Scorecard Context:

* **Y = f(X1, X2, ..., Xn)**
* Among all possible Xs, **Vital Xs are the few that drive Y the most.**

#### 🧭 Steps to Determine Vital Xs:

1. **Define the output Y** (e.g., reduce delivery time, increase satisfaction)
2. **Brainstorm possible Xs** (causes, variables affecting Y)
3. **Use tools** like:
   * Cause & Effect Diagrams (Fishbone)
   * Process Maps
   * FMEA (Failure Mode & Effects Analysis)
   * Correlation and Regression Analysis
4. **Validate Xs** using statistical tests (e.g., hypothesis testing, ANOVA)
5. **Prioritize** based on impact and feasibility

#### 🎯 Example:

**Y:** Customer Satisfaction  
**Possible Xs:**

* Product Quality
* Call Center Response Time
* Delivery Accuracy
* Ease of Website Navigation

If analysis shows **Delivery Accuracy** has the strongest correlation with satisfaction, it becomes a **Vital X**.

### 📣 Voice of the Customer (VoC)

**Definition**:  
Voice of the Customer refers to the **stated and unstated needs, wants, and preferences** of the customer. It’s a critical input for designing products, services, and processes that truly satisfy the end user.

"Customers define quality. Understanding them is step one."

### 🎯 Why Is VoC Important?

* Helps create products/services that match real customer expectations.
* Reduces risk of product failure or poor adoption.
* Aligns internal efforts with customer-driven priorities.

### 🧭 **Three Key Steps to Understand the Voice of the Customer**

| **Step** | **Description** |
| --- | --- |
| **1. Identify the Customer** | Know who your internal and external customers are (e.g., end-users, partners, stakeholders). |
| **2. Collect & Analyze Data** | Use surveys, interviews, focus groups, complaints, social media, customer reviews, etc. to gather insights. |
| **3. Determine Critical Requirements** | Translate customer input into measurable requirements (Critical to Quality – CTQs). |

### 🛠️ Tools for VoC:

* Surveys & Questionnaires
* Interviews & Focus Groups
* Observation/Shadowing
* Kano Model (to classify customer needs)
* Affinity Diagrams (to organize feedback)

### 💡 Example:

A customer says:

“I want fast delivery.”  
This might translate to a **CTQ (Critical to Quality)**:  
Delivery time ≤ 2 days

### 🧍 Identify the Customer & 💰 Calculate the Value of Customer Loyalty (Continued)

#### 📌 Why Focus on Customer Loyalty?

* **Acquiring new customers** is expensive (marketing, onboarding, promotions).
* **Retaining existing customers** is more cost-effective and profitable in the long term.
* Loyal customers:
  + Buy more frequently
  + Are less price-sensitive
  + Refer others (creating organic growth)

### 💸 **Calculating the Financial Value of Customer Loyalty**

To understand how valuable a loyal customer is, calculate their **Customer Lifetime Value (CLV)**:

CLV=Average Purchase Value×Purchase Frequency×Customer Lifespan\text{CLV} = \text{Average Purchase Value} \times \text{Purchase Frequency} \times \text{Customer Lifespan}CLV=Average Purchase Value×Purchase Frequency×Customer Lifespan

This helps businesses decide:

* How much to invest in retention efforts
* What services and experiences are justified by the long-term value

### 🏬 **Real-World Example: Walmart Inc.**

Walmart’s loyalty strategy illustrates how major companies retain customers:

| **Loyalty Element** | **Walmart’s Strategy** |
| --- | --- |
| **Customer Identification** | Tracks customer journey from childhood to old age |
| **Low Prices** | Everyday low prices strategy |
| **Wide Selection** | Broad product variety to meet all needs |
| **Friendly Service** | Greeters at every store, helpful staff |
| **Easy Returns** | “Refund with a smile” policy builds trust |

✅ Although these initiatives increase operational costs, **Walmart recovers these costs** through increased **customer retention and repeat sales**, demonstrating the **value of long-term customer loyalty**.

### 🔍 Identify the Customer & 💸 Calculate the Value of Customer Loyalty (Continued)

#### ✅ Why Customer Loyalty Matters:

* **Acquiring new customers is costly** (marketing, advertising, onboarding).
* **Retaining existing customers** is far more cost-effective.
* Loyal customers:
  + Spend more over time
  + Are more forgiving of mistakes
  + Promote your brand through word-of-mouth
  + Cost less to serve (they know how to use the product/service)

### 📊 Financial Value of Customer Loyalty

To calculate how valuable a loyal customer is:

* Estimate **total sales/revenue** from that customer over a defined period (often called **Customer Lifetime Value – CLV**).
* Helps decide:
  + How much to spend on retention
  + What kinds of loyalty programs or services are justifiable

**Basic CLV Formula**:

CLV=(Average Transaction Value)×(Purchase Frequency)×(Customer Lifespan)\text{CLV} = (\text{Average Transaction Value}) \times (\text{Purchase Frequency}) \times (\text{Customer Lifespan})CLV=(Average Transaction Value)×(Purchase Frequency)×(Customer Lifespan)

### 🏪 **Walmart Example – Customer Loyalty in Action**

Walmart, one of the world’s largest retail chains, focuses intensely on long-term customer retention. Here's how:

| **Strategy** | **Description** |
| --- | --- |
| **Identify Customers Early** | Tracks customers from childhood through adulthood |
| **Everyday Low Prices** | Keeps pricing affordable to retain loyalty |
| **Wide Product Selection** | Offers everything from groceries to electronics under one roof |
| **Friendly Service** | Greeters at entrances, customer-centric staff |
| **Easy Returns** | “Refund with a smile” policy boosts confidence and repeat business |

🔁 **Yes, customer focus increases costs**, but:

Walmart's loyalty strategy pays off by increasing **repeat purchases**, improving **lifetime customer value**, and reducing the need for constant customer acquisition.

### 📊 **Data Collection and Analysis**

#### ✅ Why It Matters:

* Six Sigma is a **data-driven** and **quantitative** methodology.
* Decisions and improvements are based on **measurable evidence**.
* **Poor data = wrong analysis = bad decisions** → failed or harmful outcomes.

### 🔎 Key Metrics Often Measured:

* **Customer-related**: Satisfaction, retention, acquisition, repeat sales
* **Market-related**: Market share
* **Employee-related**: Retention, morale, training, skills
* **Process-related**: Cycle time, defect rate, availability of frontline info

### ⚠️ Risks of Poor Data Collection:

* Misleading trends or patterns
* Inaccurate identification of root causes
* Wasted resources on wrong solutions
* Loss of stakeholder trust in Six Sigma initiatives

### 🗂️ **Sources of Data**:

| **Source Type** | **Examples** |
| --- | --- |
| **Internal Records** | Sales data, customer service logs, HR data |
| **Surveys** | Customer satisfaction, employee feedback |
| **Interviews** | In-depth feedback from key stakeholders |
| **Observations** | Watching processes to note delays, errors |
| **System Logs** | IT systems, CRM, ERP (e.g., SAP, Salesforce) |
| **External Benchmarks** | Industry reports, competitor data |

### 🧰 **Data Collection Techniques**:

| **Technique** | **Use Case** |
| --- | --- |
| Check Sheets | Tracking frequency of events (e.g. defects) |
| Surveys & Questionnaires | Customer or employee input |
| Interviews | Deep insights and qualitative feedback |
| Direct Observation | Validating process steps visually |
| Automated Systems | Reliable, consistent large-scale data |
| Sampling | Cost-effective when full data is impractical |

### 🧠 Best Practices:

* Define clear **data collection objectives**.
* Ensure **data accuracy**, **completeness**, and **consistency**.
* Use the **right tools** for analysis (e.g., control charts, Pareto analysis, histograms).
* Always question: “Is this data valid and representative?”

### 📊 **Sources of Data – With Examples & Collection Techniques**

| **Source of Data** | **Examples of Data Available** | **Examples of Data Collection Techniques** |
| --- | --- | --- |
| **External Environment & Competitors** | Market share, industry growth, product features | Market research, competitor benchmarking, publications, reports |
| **Financials** | Sales, profits, growth, ROI, return on capital employed | Company financial reports, balance sheets, P&L statements |
| **Company Processes** | Defect rates (DPMO), cycle time, process efficiency | Process measurement, time studies, internal audits |
| **Customers** | Satisfaction scores, brand perception, loyalty | Surveys, interviews, focus groups, customer observations |

### 📊 **Data Types in Six Sigma**

In Six Sigma, data is classified based on how it is measured. Understanding **whether data is discrete or continuous** is essential because **different tools and techniques** are used for analysis depending on the data type.

### 🔢 1. **Discrete Data** (aka Attribute Data)

* **Definition**: Countable values; finite numbers or categories.
* **Cannot be broken into smaller meaningful parts** (e.g., 3 defects—not 2.5 defects).

**Examples**:

* Number of people who bought a product
* Number of customer complaints per month
* Defects per 1,000 units
* Yes/No survey responses
* Number of employees trained

### 📏 2. **Continuous Data** (aka Variable Data)

* **Definition**: Measurable values that can take **any value within a range**.
* **Can be broken into decimals or fractions**.

**Examples**:

* Weight of packages
* Time taken to resolve a customer complaint
* Length of a product
* Average delivery speed
* Temperature readings

### 🧠 Why It Matters:

Correctly identifying the **type of data** ensures the **right Six Sigma tools** are used for analysis.

| **Data Type** | **Typical Tools Used** |
| --- | --- |
| **Discrete** | Control Charts (p, np, c, u), Pareto Charts |
| **Continuous** | Control Charts (X̄-R, X̄-S), Histograms, Box Plots |

✅ **Quick Check**:

* If you can **count it** → It's **Discrete**
* If you can **measure it** → It's **Continuous**

### 📋 **Important Data Collection Techniques: Surveys**

Surveys are a powerful method in Six Sigma to gather **customer voice**, preferences, and satisfaction levels. Since it's often impractical to ask every customer, **a sample group is surveyed**, and insights are then extrapolated to represent the larger population.

### 🎯 **Purpose in Six Sigma:**

* Capture **quantitative and qualitative** customer feedback.
* Identify **critical-to-quality (CTQ)** attributes.
* Make **data-driven decisions** that are aligned with customer expectations.

### ✅ **Why Surveys Must Be Done Carefully:**

* Survey data directly impacts key Six Sigma project decisions.
* Poorly designed or biased surveys can lead to **misinterpretation**, incorrect root cause analysis, and **ineffective solutions**.

### 🔍 **3 High-Level Steps in Survey Design:**

| **Step** | **What It Involves** |
| --- | --- |
| 1. **Design the Survey** | - Define clear objectives |

* Choose question types (open-ended, Likert scale, yes/no)
* Keep questions unbiased, neutral, and relevant |  
  | 2. **Administer the Survey** | - Select a representative sample
* Choose delivery mode (online, in-person, phone, etc.)
* Ensure high response rate through reminders or incentives |  
  | 3. **Analyze Survey Results** | - Use statistical tools (mean, frequency, variance, etc.)
* Identify patterns and trends
* Convert responses into measurable CTQs and Vital Xs |

### 💡 Tips for Effective Surveys:

* Avoid **leading or ambiguous** questions.
* Use **scales consistently** (e.g., 1–5 rating: 1 = Very Unsatisfied → 5 = Very Satisfied).
* Pre-test the survey (pilot test) before full rollout.
* Ensure **anonymity/confidentiality** to encourage honest feedback.

### 📝 **a) Creating and Validating the Questionnaire**

Creating a high-quality survey questionnaire is **essential** for collecting accurate and actionable data in Six Sigma. Poorly designed questions can lead to **bias, confusion, or misleading results**.

### 🎯 **1. Determining Types of Questions**

| **Question Type** | **Purpose** | **Examples** |
| --- | --- | --- |
| **Demographic** | Understand **who** the customer is | Age, gender, income, nationality |
| **Attitudinal** | Explore customer **opinions, preferences, expectations** | "What do you like most about the product?" |
| **Service/Product Attributes** | Measure customer perceptions of **specific features or service elements** | "Rate the quality of packaging, speed of service, etc." |

### 📋 **2. Determining Response Types**

| **Response Type** | **Explanation** | **Example** |
| --- | --- | --- |
| **Open-Ended** | Allows customers to provide **free-text answers**; useful for **qualitative insights** | “What is your perfect holiday?” → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Rating Questions** | Uses a **scaled response** to measure **satisfaction or perception**; helps with quantification | “How would you rate our customer service?”  🔹 Very Good 🔹 Good 🔹 Satisfactory 🔹 Poor |

### 🧪 **Validation of Questionnaire**

* **Pilot Testing**: Conduct a small-scale test to detect confusing or leading questions.
* **Check for Bias**: Avoid loaded or double-barreled questions.
* **Clarity and Simplicity**: Ensure each question is **easy to understand** and **focused on one idea**.
* **Consistency**: Keep **scales consistent** (e.g., always 1–5 or 1–7) to avoid confusion.
* **Neutral Language**: Don’t influence customer response through suggestive wording.

### 🛠️ Practical Tip:

Combine **open-ended** questions (for insights) with **rating/closed-ended** questions (for measurable data).

## 📋 **Conducting Surveys (continued)**

### 🧾 **More Question Types**

| **Question Type** | **Purpose** | **Example** |
| --- | --- | --- |
| **Ranking Questions** | Ask customers to **rank multiple attributes** in order of preference or satisfaction | "Rank the following product features from 1 (Most Satisfied) to 5 (Least Satisfied)" |
| **Yes/No Questions** | Simple binary response; useful for **clear-cut decisions or qualifications** | "Do you earn more than $50,000 per year?" → Yes / No |
| **Likert / Intensity Scale** | Measures the **degree of agreement, satisfaction, or importance** | "How strongly do you agree with the statement: 'The staff were helpful'" 🔘 Strongly Agree → Strongly Disagree |

### 🧪 **Validating the Questionnaire**

Once your survey is designed, it's important to **validate** it before using it in a Six Sigma project. Poorly validated questions can lead to **unreliable or misleading data**.

#### ✅ **Validation Steps:**

1. **Content Review**:
   * Ensure questions **match the survey objectives**.
   * Check that every question is **relevant and non-redundant**.
   * Language should be **simple, neutral, and culturally appropriate**.
2. **Pilot Study**:
   * Share the questionnaire with a **small group of target respondents**.
   * Observe if any questions are:
     + Misinterpreted
     + Too long or unclear
     + Eliciting incomplete responses
   * Gather **feedback on survey flow and clarity**.
3. **Adjust and Finalize**:
   * Make edits based on feedback.
   * Ensure logical sequencing (e.g., start with easy/demographic questions, end with sensitive ones).
   * Standardize **response scales** to avoid confusion (e.g., 1–5 or 1–7 consistently).

### 🛠️ Pro Tip:

Always **test the survey** on at least 5–10 people before full deployment. Even simple word changes can dramatically affect customer interpretation.

### **b) Sending the Questionnaire to Respondents**

Once the questionnaire is **validated**, it needs to be distributed to a **representative sample** of the target population.

#### ✅ Common Distribution Channels:

| **Method** | **Description** | **Use When** |
| --- | --- | --- |
| **Email Surveys** | Sent via email links or embedded forms | Quick feedback, low cost, digitally engaged customers |
| **Web-Forms / Online Tools** | Hosted on websites or survey platforms (e.g., Google Forms, SurveyMonkey) | Easy tracking, real-time analytics, broad reach |
| **Physical Mail** | Printed surveys sent via post | Older or rural populations, less tech-savvy users |
| **Face-to-Face Delivery** | Delivered and collected by staff or interviewers | High response rates, better for detailed surveys or low-literacy audiences |
| **Phone Surveys** | Conducted through phone interviews | When verbal explanations or clarifications are needed |

### **c) Collecting and Analyzing the Data**

Once responses are received, they are **organized and analyzed** to derive meaningful insights.

#### ✅ Key Steps in Data Collection & Analysis:

1. **Data Entry**:
   * Responses from physical forms are **digitized**.
   * Online responses are often **automatically stored** in spreadsheets/databases.
2. **Data Cleaning**:
   * Remove incomplete, duplicate, or inconsistent responses.
   * Ensure formats (e.g., date, numeric scales) are standardized.
3. **Data Analysis Tools** (depending on question type):

| **Question Type** | **Analysis Tool/Technique** |
| --- | --- |
| Yes/No / Closed-ended | Frequency counts, percentages |
| Rating Scales | Mean, median, mode, standard deviation |
| Ranking | Weighted average rankings |
| Open-ended | Thematic analysis, word clouds, sentiment analysis |
| Likert Scale | Cross-tabulation, correlation, trend analysis |

1. **Interpretation & Action**:
   * Translate insights into **actionable improvements** for products, processes, or services.
   * Prioritize improvements based on **customer impact and effort/cost analysis**.

### 🧠 Example:

Imagine you're conducting a customer satisfaction survey for a logistics company. The findings show:

* **90% satisfaction** with delivery speed (Yes/No).
* **Average rating of 3.2/5** for customer support quality (Likert).
* **Common complaint**: “Hard to reach support” (Open-ended).

**Action Plan**: Hire more support staff, offer chatbot services, reduce hold time.

## 🧠 **Important Data Collection Techniques: Focus Groups**

### 📌 What is a Focus Group?

A **focus group** is a small group (typically **6–10 participants**) selected for a structured discussion, aimed at evaluating a product, service, or concept. Members share common traits relevant to the topic (e.g., current users of a brand or service).

### 🎯 **Purpose of Focus Groups**

* Gather **qualitative insights** about customer experiences, expectations, and suggestions
* Identify **improvement areas** in current offerings
* Generate **new ideas** and innovations
* Validate product concepts or proposed changes before implementation

### 👥 **Role of the Facilitator**

A skilled **facilitator** ensures:

* A safe, open environment for discussion
* Everyone has a chance to speak
* Key topics are covered while staying on track
* Clarification is obtained on relevant issues
* Bias is minimized and dominant voices don’t override the group

### ✅ **Advantages of Focus Groups**

| **Benefit** | **Explanation** |
| --- | --- |
| Rich, open-ended feedback | Allows for in-depth understanding of attitudes, behaviors, and emotions |
| Quick idea generation | Encourages brainstorming and spontaneous suggestions |
| Easy to organize | Requires minimal setup and cost compared to large-scale surveys |
| Exploratory | Useful in the early phases of product or service development |

### ⚠️ **Limitations of Focus Groups**

| **Challenge** | **Explanation** |
| --- | --- |
| Small sample size | May not be representative of the entire customer base |
| Dependent on facilitator | Poor moderation can lead to biased or incomplete results |
| Groupthink risk | Participants may conform to dominant opinions instead of sharing unique views |
| Hard to quantify | Qualitative data is harder to analyze statistically |

## 🔍 **Other Key Data Collection Techniques**

| **Technique** | **Description** |
| --- | --- |
| **Interviews** | One-on-one, in-depth conversations used to explore individual thoughts, needs |
| **Observation** | Watching customer behavior in real settings (e.g., in stores, on websites) |

### 📘 Summary

| **Method** | **Best Used For** |
| --- | --- |
| Focus Groups | Exploring ideas, evaluating perceptions, early-stage research |
| Interviews | Deep dives into individual experiences or expert feedback |
| Observations | Understanding actual behavior vs. reported preferences |

## 📘 STUDY NOTES: Kano Model – Understanding What Customers Really Want

🎯 **Purpose**:  
The **Kano Model** helps us understand **which product features** truly **satisfy customers**, which are just **expected**, and which features **delight** them.

## 🔍 What is the Kano Model?

Developed by **Professor Noriaki Kano**, this model groups product/service features into **3 categories** based on **customer perception** and **emotional response**.

## 🧩 1. Threshold / Basic Needs (💥 Must-Haves)

* ❗ These are **expected** features.
* 🧠 Customers don’t get excited if they’re present.
* 😠 But they get **very upset** if they are missing.
* 💬 “Of course this should be included!”

### 📌 Examples:

* Seatbelts in cars
* Wi-Fi in a hotel
* Water in a restaurant

✅ **Key Point**: You must provide these. No rewards, only punishment if absent.

## 🚀 2. Performance Needs (📈 More is Better)

* ⬆️ The **more** you provide, the **happier** the customer.
* ⬇️ The **less** you provide, the **more upset** they are.
* 💬 “I expect this, and the better it is, the more I love the product!”

### 📌 Examples:

* Battery life in smartphones
* Internet speed
* Fuel efficiency in cars

✅ **Key Point**: Directly tied to **customer satisfaction**. Focus on **improving** these.

## 🎁 3. Attractive Needs (🎉 Delighters)

* 😍 Unexpected and **exciting** features.
* 🆕 Often **innovative** — customers didn’t know they wanted them.
* 💬 “Wow! I wasn’t expecting this!”

### 📌 Examples:

* Free upgrade at a hotel
* Face recognition in phones (when first introduced)
* Heated steering wheels in cars

✅ **Key Point**: Create **surprise and delight**. They **differentiate you** from competitors.

## 🌀 The Kano Curve – Visual Aid

perl

CopyEdit

↑ Customer Satisfaction

|

😀 | /

| /

| /

😐 |------/----------> Feature Performance

| /

😠 | /

|

* Below line = **Basic**
* Diagonal line = **Performance**
* Above line = **Attractive**

## 🔄 Kano Insights Over Time

Features may **move** from one category to another as **customer expectations evolve**.

### Example:

* Airbags in cars →  
  🔹 **Used to be** attractive  
  🔸 Now a **basic necessity**

## 💼 Practical Use in Lean Six Sigma

* ✅ Use **Kano Model** during **Voice of the Customer (VOC)** analysis
* ✅ Helps **prioritize features** in product/service design
* ✅ Supports **Quality Function Deployment (QFD)** in the **Design for Six Sigma (DFSS)** phase

## 🧠 Easy-to-Remember Trick:

🎵 Think of it like **3 Levels of Happiness**:

* **"Must"** (Basic) = No joy, only anger if missing
* **"More"** (Performance) = Happy with more
* **"Wow!"** (Attractive) = Unexpected delight

## 📘 KANO MODEL – CONTINUED

🎯 Linking Kano to Lean Six Sigma Goals

### 🔧 Six Sigma’s Role in Kano Model

Six Sigma doesn't only aim to **remove defects** — it also supports **customer delight** by improving **product features** across **all Kano categories**.

### 🪓 1. Fixing What’s Broken – Below the Line (📉)

* Six Sigma tools help identify and eliminate **defects** or **missing basic attributes**.
* These are the **"must-have" features** (Threshold attributes).
* Failing here = customer dissatisfaction → 💔

**Example**:  
If car brakes fail occasionally, customers won’t care about luxury — they will just stop trusting the product.

🔍 **Tool Used**:  
DMAIC (Define–Measure–Analyze–Improve–Control) to **remove process variation** and **improve consistency**.

### 📈 2. Optimizing Performance Features

* Six Sigma improves **Performance Attributes** by:
  + Reducing errors
  + Increasing consistency
  + Enhancing speed or efficiency
* This **directly improves customer satisfaction**.

**Example**:  
Reducing food delivery time from 40 to 25 minutes reliably = happier customers.

🔍 **Tool Used**:  
Statistical Process Control, Regression, DOE (Design of Experiments)

### 🎯 3. Identifying "Wow!" Features (Delighters)

* Though not a primary Six Sigma focus, it **helps discover Attractive Attributes** using tools like:
  + **Voice of Customer (VOC)**
  + **Kano Analysis**
  + **QFD (Quality Function Deployment)**

**Example**:  
Adding predictive service alerts in a car (e.g., tire pressure low → auto-book a service slot).

✅ These delighters:

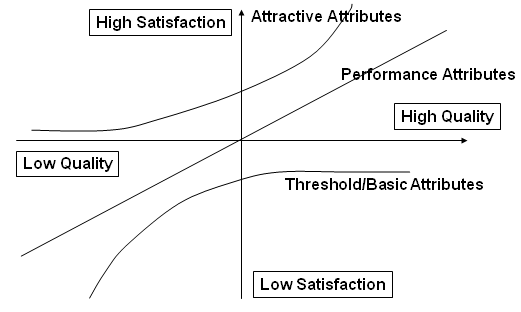
* Differentiate your brand
* Increase **loyalty and retention**
* Drive **long-term competitive advantage**

### 📊 Summary Table: Kano Meets Six Sigma

| **Kano Category** | **Six Sigma Action** | **Tools/Approach** |
| --- | --- | --- |
| Basic (Threshold) | Eliminate defects & ensure minimum standards | DMAIC, FMEA, Root Cause Analysis |
| Performance | Improve feature quality, speed, reliability | SPC, DOE, Regression |
| Attractive (Delighters) | Identify unexpected needs, boost customer delight | VOC, Kano Analysis, QFD, Innovation |

### 🧠 Interview-Ready Quote:

"Six Sigma not only reduces defects below customer expectations, but also supports innovation by identifying delighters through tools like VOC and Kano analysis – ensuring both quality **and** emotional satisfaction."



## 🏠 QUALITY FUNCTION DEPLOYMENT (QFD) – aka House of Quality

### 🎯 What Is It?

**QFD** is a structured method used to **translate customer requirements** (Voice of Customer or **VOC**) into specific **product or service features** and **internal processes**.

✅ Think of QFD as the **bridge** between what the **customer wants** and what the **company builds**.

### 🗣️ Why Use QFD?

* Aligns product design with **customer expectations**
* Ensures **cross-functional collaboration** (Marketing, Design, Engineering, Manufacturing)
* Helps **prioritize features** based on customer needs and competitive analysis
* Drives **customer satisfaction** and **strategic decision-making**

### 🧠 Key Concept: The “House of Quality”

The **House of Quality** is the **main matrix** used in QFD. It looks like a house 🏠 because of its layout, with different sections for data.

Here's what each “room” means:

| **Section (Room)** | **Purpose** |
| --- | --- |
| Customer Requirements (VOC) | What the customer wants ("Whats") |
| Technical Requirements | How the company will meet those needs ("Hows") |
| Relationship Matrix | Shows strength of relationship between “Whats” and “Hows” |
| Technical Correlation (Roof) | Shows where technical requirements may support or conflict with each other |
| Competitive Benchmarking | Compares your product to competitors on each requirement |
| Prioritization | Weights each requirement based on customer importance |

### 🧩 Example (Simplified):

**Product**: New smartphone  
**Customer Needs (Whats)**:

* Long battery life
* Fast charging
* Lightweight design

**Technical Requirements (Hows)**:

* Battery capacity
* Charging technology
* Material used for casing

In QFD, you'd create a matrix that maps **each “What” to each “How”**, assign scores (weak/medium/strong relationship), and **prioritize efforts** based on customer importance and competition.

### 🛠️ How It’s Used in Six Sigma Projects:

1. **During Define & Measure phases** to gather VOC
2. Guides product/service development in **DMAIC or DMADV**
3. Helps align business strategy with **customer-centric goals**
4. Works well alongside **Kano Model** to rank **Must-Haves**, **Performance**, and **Delighters**

### 🧠 Interview Tip:

"QFD, and specifically the House of Quality, helps translate the voice of the customer into prioritized technical requirements. It's key to ensuring that product development aligns with both customer needs and strategic goals.”

### 📝 Quick Recap:

| **Feature** | **Details** |
| --- | --- |
| Purpose | Convert VOC into design specs |
| Key Output | House of Quality Matrix |
| Who’s Involved | Cross-functional teams (marketing, R&D, operations) |
| Benefits | Customer-focused design, competitive edge |
| Lean Six Sigma Use | Define, Measure, Analyze (especially in DMADV) |

## 🏠 **Quality Function Deployment (QFD)**

**Also known as:** House of Quality

### 🎯 **Purpose of QFD**

To translate **customer needs** (Voice of the Customer or VOC) into:

✅ Product features  
✅ Process requirements  
✅ Design specifications  
✅ Competitive positioning

### 🗣️ **How It Works:**

1. **Customer Inputs → Technical Actions**  
   It starts with gathering the **VOC** — what customers truly want.
2. **Team Effort Across Departments**  
   A **cross-functional team** (design, quality, marketing, production) works together.
3. **Prioritization of Features**  
   Features are rated based on customer importance + feasibility + competitive analysis.
4. **Outcome = House of Quality**  
   A visual matrix that shows:
   * What customers want
   * How the company will deliver it
   * How important each feature is
   * How your product compares to competitors

### 🏡 **Structure of the House of Quality (Simplified)**

| **Section** | **Meaning** |
| --- | --- |
| 📢 Customer Requirements | "What" the customer wants (e.g., fast charging in a phone) |
| 🛠 Technical Requirements | "How" the company will meet the need (e.g., high-watt charger) |
| 🔁 Relationship Matrix | Shows strength of connection between each “What” and “How” |
| 🏗 Roof (Correlation) | Identifies relationships/conflicts between technical features |
| 📊 Competitive Analysis | Compares company product to competitors on each requirement |
| 🧮 Importance Ratings | Helps **prioritize efforts** based on customer importance |

### ✏️ **Example:**

**Product:** Designing a new electric scooter  
**Customer Needs (Whats):**

* Long battery range
* Lightweight
* Quick recharge time

**Technical Requirements (Hows):**

* Battery capacity
* Motor efficiency
* Charging port design

👉 The House of Quality would link each What to a How, assign priority scores, and show where we beat or lag behind competitors.

### ✅ **Why It’s Important in Six Sigma:**

| **Benefit** | **Lean Six Sigma Context** |
| --- | --- |
| Customer-focused design | Aligns with VOC (Voice of Customer) |
| Cross-functional collaboration | Encourages teamwork across departments |
| Competitive benchmarking | Helps stay ahead in market offerings |
| Supports project scoping | Defines clear, measurable product goals |

### 💡 **Interview-Ready Talking Point:**

“QFD helps us align what customers want with how we deliver it, using the House of Quality matrix. It supports better planning, innovation, and ensures customer satisfaction stays central throughout the design process.”

## 🏠 QUALITY FUNCTION DEPLOYMENT (QFD) – House of Quality (Complete Version)

### 🎯 **Quick Refresher: What is QFD?**

QFD is a method to **translate the Voice of the Customer (VOC)** into **technical features**, **design specs**, and **process plans** to ensure products or services meet (or exceed) customer expectations.

### 🧱 **Main Components of the House of Quality:**

| **Section** | **Description** |
| --- | --- |
| 📢 **Customer Requirements** (Whats) | What the customer wants. Direct inputs from VOC. |
| 🛠 **Technical Requirements** (Hows) | How the organization will fulfill customer wants. |
| 🔁 **Relationship Matrix** | Shows how strongly each technical "How" supports each customer "What". |
| 🧠 **Technical Correlation** (Roof) | Reveals conflicts/synergies between technical requirements. |
| 🧮 **Importance Weighting** | Rates the customer requirements by importance (1–5 scale or %). |
| 💰 **Cost to Accomplish** | Estimated cost (from Finance) to deliver a specific design feature. |
| 🎯 **Target Values** | Ideal values or performance goals for each technical feature. |
| 📊 **Planning (Competitive Evaluation)** | How your product compares to competitor offerings on each customer need. |

### 📝 **Expanded Explanation of New Sections:**

#### 🔍 1. **Planning (Competitive Evaluation)**

* Compares **your product** to **competitors** on each customer requirement.
* Helps **identify gaps**, **areas of strength**, and **market opportunities**.
* Example: If your competitor scores 9/10 on “Battery Life” but you’re at 6/10 → time to improve!

#### 🎯 2. **Target Values**

* These are **design targets** set by your team to meet or exceed customer expectations.
* Example: Customer wants a “fast-charging phone.” Your target value might be “80% charge in 30 mins.”

#### 💸 3. **Cost to Accomplish**

* What it will cost (in time, money, or effort) to achieve the technical requirements or target values.
* Helps balance **cost-benefit** during product development.

#### 🧮 4. **Importance Weighting**

* Prioritizes customer requirements based on surveys or market data.
* This influences how much focus and resources go toward each feature.
* Example: If “battery life” has a weight of 9 and “screen brightness” has a 5, more focus goes to battery.

### 🧠 **Example – Smartphone Launch QFD**

| **📢 Customer Requirement** | **Weight** | **🛠 Technical Feature** | **Relationship** | **Target Value** | **Cost to Accomplish** | **Competitive Rating** |
| --- | --- | --- | --- | --- | --- | --- |
| Long battery life | 9 | Battery capacity | Strong (●●●) | 5000mAh | High ($$$) | Competitor A: 8/10 |
| Fast charging | 8 | Charger wattage | Medium (●●) | 60W | Medium ($$) | Competitor A: 7/10 |
| Lightweight | 6 | Material used | Weak (●) | <180g | Low ($) | Competitor A: 9/10 |

### 💡 **Why It’s Powerful for Six Sigma:**

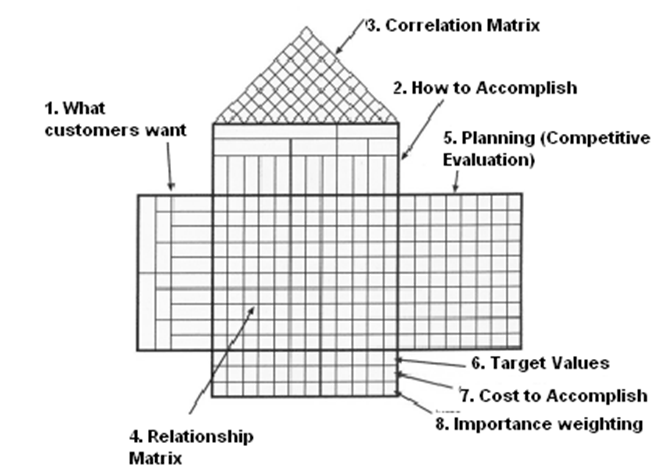
* **Improves design quality** by putting customer first
* Helps **prioritize improvements**
* Builds **alignment across departments**
* Combines well with **Kano Model** and **FMEA**
* Supports **Define, Measure, Analyze, Design** phases in DMAIC/DMADV

### 🧠 Interview-Ready Soundbite:

“Using QFD helps us turn customer expectations into engineering language. It also allows us to see how we compare with competitors and helps prioritize features based on customer value and implementation cost.”

### 📌 Summary Table: QFD Key Elements

| **Element** | **Purpose** |
| --- | --- |
| Customer Requirements | What customers want |
| Technical Requirements | How the company delivers on those wants |
| Relationship Matrix | Strength of “What” to “How” connections |
| Technical Correlation (Roof) | Compatibility/conflict between technical requirements |
| Importance Weighting | Priority of customer needs |
| Target Values | Desired performance levels |
| Cost to Accomplish | Feasibility in terms of resources |
| Competitive Evaluation | How product stacks up vs. competition |



# 📊 Benchmarking – Learning from the Best to Improve

### 🎯 **Definition:**

**Benchmarking** is the process of **comparing your company’s processes and performance metrics** to the **best-in-class companies** to learn and adopt **best practices** that help you **close performance gaps and boost quality**.

### 🧠 Why is Benchmarking Important in Six Sigma?

* Identifies **performance gaps**
* Encourages **continuous improvement**
* Helps define **realistic goals** based on proven success
* Supports strategic planning and DMAIC (especially **Improve** & **Control** phases)

### 🧱 4 Phases of Benchmarking (Robert Camp Model – Public Sector Management)

## 🧭 **PHASE 1: PLANNING**

🔹 **Step 1: Identify What to Benchmark**

* Decide which **process, product, or function** to improve.
* 🔍 Example: You want to benchmark your **customer service** process.

🔹 **Step 2: Identify Who to Benchmark Against**

* Find **external companies or internal departments** with **superior performance**.
* 🔍 Example: Compare with **Amazon's customer support** model.

## 📊 **PHASE 2: ANALYSIS**

🔹 **Step 3: Determine Data Sources**

* Decide what type of data to collect:
  + KPIs
  + Customer satisfaction
  + Productivity
* 📁 Source: Surveys, industry reports, internal dashboards

🔹 **Step 4: Understand Internal Performance**

* Get a **full picture** of your own processes.
* Helps find the **performance gap** between current state and benchmark.
* 🔍 Tip: Use tools like SIPOC, Value Stream Mapping, and dashboards

➡️ The remaining phases (Phase 3: Integration, Phase 4: Action) will follow in your next lesson, but here's a **visual so far**:

### 📌 Visual Summary: Benchmarking Phases (Steps 1–4)

plaintext

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📘 PHASE 1: PLANNING

-------------------------

1️⃣ What to benchmark?

🔎 Process, function, product

2️⃣ Who to benchmark against?

🏆 Best-in-class competitors or top-performing internal teams

📘 PHASE 2: ANALYSIS

-------------------------

3️⃣ What data sources to use?

📊 KPIs, reports, surveys

4️⃣ What is our current performance?

🧭 Baseline data to identify performance gap

### 💬 Interview-Ready Answer:

“Benchmarking helps identify performance gaps by comparing our practices with industry leaders. For example, if our customer service resolution time is 3 hours but Amazon resolves in 30 minutes, we know the gap and can study their methods to improve ours.”

### 📌 Real-World Example:

| **🏢 Your Company** | **📞 Customer Response Time** |
| --- | --- |
| Local Telecom Provider | 2 hours |
| 💡 Benchmark: Amazon | 15 minutes |
| 📉 Gap Identified | 1 hour 45 minutes |

➡️ **Result:** Adopt live-chat automation, agent performance dashboards, and AI-based ticket prioritization.

# 📊 Benchmarking – Learning from the Best to Improve

### 🧠 What is Benchmarking?

A continuous improvement technique that involves **comparing your processes, performance, or products with best-in-class competitors** to **adopt or adapt superior practices**.

## 🔁 The 4 Phases of Benchmarking (Robert Camp’s 10-Step Process)

### 📘 **Phase 1: PLANNING**

| **Step** | **Description** | **Example** |
| --- | --- | --- |
| **1** | Identify what to benchmark | Customer service, lead time, inventory turnover |
| **2** | Identify who to benchmark against | Amazon, Toyota, or best-performing departments |

### 📊 **Phase 2: ANALYSIS**

| **Step** | **Description** | **Example** |
| --- | --- | --- |
| **3** | Choose data sources | KPIs, customer surveys, reports |
| **4** | Understand current performance | Use dashboards, SIPOC, process maps |

### 💡 **Phase 3: INTEGRATION**

| **Step** | **Description** | **Example** |
| --- | --- | --- |
| **5** | **Develop a Vision** for future operations based on benchmarking insights | “We aim to resolve customer queries in 15 mins, like Amazon.” |
| **6** | **Report progress** across the company and gather feedback | Use newsletters, meetings, dashboards, feedback sessions |

🔔 **Goal:** Involve everyone. Benchmarking is not a secret project!

### 🚀 **Phase 4: ACTION**

| **Step** | **Description** | **Example** |
| --- | --- | --- |
| **7** | Set **functional goals** based on vision | “Reduce downtime by 20% in 6 months.” |
| **8 & 9** | Create & implement action plans with those who **do the work** | Operators and analysts lead improvement initiatives |
| **10** | **Update knowledge**—continue learning and benchmarking | Annual reviews, stay updated on industry trends |

### ✅ Summary Table: Benchmarking Steps at a Glance

| **Phase** | **Step** | **Key Focus** |
| --- | --- | --- |
| Planning | 1 | What to benchmark |
| Planning | 2 | Who to benchmark |
| Analysis | 3 | Data sources |
| Analysis | 4 | Identify performance gap |
| Integration | 5 | Future vision |
| Integration | 6 | Communication & feedback |
| Action | 7 | Set goals |
| Action | 8 & 9 | Action plan & implementation |
| Action | 10 | Continuous improvement |

### 🧠 Easy-to-Remember Mnemonic:

**P.A.I.A.** = **Plan, Analyze, Integrate, Act**

**“Plan like the best, Analyze the gap, Integrate their vision, and Act smarter.”**

### 💬 Interview-Ready Talking Point:

“Benchmarking helps us look beyond our company walls. I’ve learned how to identify best-in-class processes, analyze our performance gaps, and implement targeted actions using Robert Camp’s 4-phase approach. It’s a key part of continuous improvement and Six Sigma’s ‘Improve’ phase.”

### 💼 Real-World Example:

**Problem**: Your warehouse has **12% order errors**, but **Amazon's error rate is <1%**.

**Actions**:

* Benchmark Amazon’s order scanning & verification process ✅
* Create warehouse retraining plan 📦
* Measure impact quarterly 📈

# 📏 **Key Process Performance Metrics in Six Sigma**

🎯 **Goal:** Measure and reduce variation or errors to improve process quality and meet customer expectations.

## ⚠️ 1. **Defects vs. Opportunities**

| **Term** | **Definition** | **Example** |
| --- | --- | --- |
| **Defect** | A failure to meet a requirement | A scratch on a phone screen |
| **Opportunity** | A chance for a defect to occur | 10 checks on one phone = 10 opportunities |

🧠 **Remember:** More complexity = More opportunities = Higher chance of defects

## ➗ 2. **DPU – Defects Per Unit**

### 🔹 Formula:

DPU=Number of DefectsNumber of Units Produced\text{DPU} = \frac{\text{Number of Defects}}{\text{Number of Units Produced}}DPU=Number of Units ProducedNumber of Defects​

### ✅ Example:

* 25 defects found in 1000 units
* DPU = 25 / 1000 = **0.025**

💡 **DPU shows average defects per product**, regardless of how many opportunities each product had.

## 📉 3. **RTY – Rolled Throughput Yield**

### 🔹 Formula:

RTY=Yield of Step 1×Yield of Step 2×⋯×Yield of Step N\text{RTY} = \text{Yield of Step 1} \times \text{Yield of Step 2} \times \dots \times \text{Yield of Step N}RTY=Yield of Step 1×Yield of Step 2×⋯×Yield of Step N

### ✅ Example:

A unit passes through 3 processes:

* A = 90% (0.90)
* B = 80% (0.80)
* C = 90% (0.90)

RTY=0.90×0.80×0.90=0.648\text{RTY} = 0.90 \times 0.80 \times 0.90 = \boxed{0.648}RTY=0.90×0.80×0.90=0.648​

📌 **RTY tells the % of units that pass ALL stages with zero defects.**

🔁 **RTY < individual yields** → process complexity reduces overall yield.

## 📊 4. **DPMO – Defects Per Million Opportunities**

### 🔹 Formula:

DPMO=Number of Defects×1,000,000Total Units×Opportunities per Unit\text{DPMO} = \frac{\text{Number of Defects} \times 1,000,000}{\text{Total Units} \times \text{Opportunities per Unit}}DPMO=Total Units×Opportunities per UnitNumber of Defects×1,000,000​

### ✅ Example:

* 20 defects
* 500 units
* 5 opportunities per unit

DPMO=20×1,000,000500×5=20,000,0002500=8000\text{DPMO} = \frac{20 \times 1,000,000}{500 \times 5} = \frac{20,000,000}{2500} = \boxed{8000}DPMO=500×520×1,000,000​=250020,000,000​=8000​

🎯 **Target in Six Sigma = < 3.4 DPMO (at 6σ level)**

## 📚 Summary Table

| **Metric** | **Formula** | **Purpose** |
| --- | --- | --- |
| **DPU** | Defects ÷ Units | Avg. defects per unit |
| **RTY** | Yield₁ × Yield₂ × ... × Yieldₙ | % of zero-defect units through all steps |
| **DPMO** | (Defects × 1M) ÷ (Units × Opportunities) | Standardized defect measure across complexity |

### 🧠 Quick Memory Hook:

**DPU** = How many mistakes  
**RTY** = What's the full pass rate  
**DPMO** = Mistakes per million chances

### 🧪 Real-Life Example

📦 **Product**: Laptop assembly

* 3 steps: Board installation (95%), OS loading (90%), Final test (98%)
* RTY = 0.95 × 0.90 × 0.98 = **0.8361 or 83.61%**

📋 500 laptops, 10 defects, 10 opportunities per laptop

* DPMO = (10 × 1,000,000) / (500 × 10) = **2000**

### 🎓 Interview Talking Point:

"I understand key metrics like DPU for defect trends, RTY to assess full process yield, and DPMO for comparing quality levels across complex products. These help identify improvement areas and track Six Sigma project results effectively."

# 💰 **Financial Measures in Project Selection**

🎯 Used to evaluate and compare improvement projects using the **time value of money**.

## 📌 1. **Present Value (PV)**

📉 **Money today is worth more than money tomorrow.**

### 🔹 Formula:

PV=Future Value (FV)(1+r)n\text{PV} = \frac{\text{Future Value (FV)}}{(1 + r)^n}PV=(1+r)nFuture Value (FV)​

Where:

* **FV** = Future value of money
* **r** = Interest or discount rate
* **n** = Number of periods (years)

### ✅ **Example:**

If you’ll receive $1000 in 3 years, and the discount rate is 5%:

PV=1000(1+0.05)3=10001.1576≈863.84\text{PV} = \frac{1000}{(1 + 0.05)^3} = \frac{1000}{1.1576} ≈ \boxed{863.84}PV=(1+0.05)31000​=1.15761000​≈863.84​

🧠 **That means $863.84 today = $1000 after 3 years at 5% interest.**

## 📊 2. **Net Present Value (NPV)**

NPV tells you if a project is **profitable** when considering the time value of money.

### 🔹 Formula:

NPV=PV of Inflows−PV of Outflows\text{NPV} = \text{PV of Inflows} - \text{PV of Outflows}NPV=PV of Inflows−PV of Outflows

### ✅ **Example:**

Suppose you invest $800 today in a project, and it returns $1000 in 1 year. Discount rate = 10%

* **PV of inflow** = 1000 / (1 + 0.10)^1 = **$909.09**
* **NPV** = 909.09 – 800 = **$109.09**

🎯 **Positive NPV = Accept the project** (It adds value)

## 🏆 Project Selection Based on NPV

### 📋 Given:

* **Project A** → NPV = $1000, duration = 5 years
* **Project B** → NPV = $800, duration = 1 year

### ✅ Which project to choose?

👉 **Choose Project A.**  
Why? Because **NPV already accounts for time**.  
Don't reject longer projects just because of time — the math handles it!

## 📚 Summary Table

| **Concept** | **Formula** | **What It Tells You** |
| --- | --- | --- |
| **PV** | FV(1+r)n\frac{FV}{(1 + r)^n}(1+r)nFV​ | Value of future money in today’s terms |
| **NPV** | PV(inflows) - PV(outflows) | Project’s total value after costs and time considered |
| **Decision Rule** | If NPV > 0 → Accept | NPV < 0 → Reject project |

### 🧠 Quick Memory Trick:

**NPV = Net Profit + Time Value**

If **NPV is positive**, the project **adds value** 💹

### 🎓 Interview-Ready Answer:

“I evaluate project benefits using NPV, which considers all cash flows and discounts them to today’s value. This helps us compare projects fairly, even if durations differ. I also understand how PV helps estimate the real worth of future returns."

# 💰 Financial Measures in Project Selection

**🎯 Purpose:** Evaluate and compare improvement projects using the **Time Value of Money** concept in Six Sigma.

## 📌 1. **Present Value (PV)**

💡 **“Money today is worth more than money tomorrow.”**

### 🔹 **Formula:**

PV=Future Value (FV)(1+r)n\text{PV} = \frac{\text{Future Value (FV)}}{(1 + r)^n}PV=(1+r)nFuture Value (FV)​

**Where:**

* FV = Future value of money
* r = Discount/interest rate
* n = Number of time periods (years)

### ✅ **Example:**

If you receive **$1000** in **3 years** with a discount rate of **5%**:

PV=1000(1+0.05)3=10001.1576≈$863.84\text{PV} = \frac{1000}{(1 + 0.05)^3} = \frac{1000}{1.1576} ≈ \boxed{\$863.84}PV=(1+0.05)31000​=1.15761000​≈$863.84​

🧠 **Meaning:** $863.84 today is **equivalent** to $1000 in 3 years at 5% interest.

## 📊 2. **Net Present Value (NPV)**

📈 **"Is the project worth doing financially after adjusting for time?"**

### 🔹 **Formula:**

NPV=PV of Inflows−PV of Outflows\text{NPV} = \text{PV of Inflows} - \text{PV of Outflows}NPV=PV of Inflows−PV of Outflows

### ✅ **Example:**

You invest **$800** today; return is **$1000** in 1 year.  
Discount rate = **10%**

PV of Inflow=1000(1+0.10)1=909.09\text{PV of Inflow} = \frac{1000}{(1 + 0.10)^1} = 909.09PV of Inflow=(1+0.10)11000​=909.09 NPV=909.09−800=109.09\text{NPV} = 909.09 - 800 = \boxed{109.09}NPV=909.09−800=109.09​

🎯 **Decision:** Since NPV is positive, the project **adds value** → **ACCEPT** ✅

## 🏆 **Project Selection Based on NPV**

### 📋 Scenario:

| **Project** | **NPV** | **Duration** |
| --- | --- | --- |
| A | $1000 | 5 years |
| B | $800 | 1 year |

✅ **Choose Project A**  
Because NPV **already factors in time**. No need to reject a longer project — the **NPV formula adjusts for that** automatically.

## 📚 Summary Table

| **💡 Concept** | **📘 Formula** | **📈 What It Tells You** |
| --- | --- | --- |
| **PV** | FV(1+r)n\frac{FV}{(1 + r)^n}(1+r)nFV​ | Present worth of future money |
| **NPV** | PV(inflows) − PV(outflows) | Net project value today |
| **Decision Rule** | If NPV > 0 → Accept | If NPV < 0 → Reject |

## 🧠 Quick Memory Trick:

**NPV = Net Profit + Value of Time**

If **NPV is positive**, the project **adds value** 💹

## 🎓 Interview-Ready Statement:

“I use NPV to compare project alternatives because it considers all expected cash flows and adjusts them for time. This ensures fair evaluation, even across different project durations. PV helps me estimate what a future return is truly worth today.”

# 💰 Financial Measures – Present Value (PV) Example (Continued)

## 🔢 **Example Problem:**

Assume you are expecting to receive **$1,100 (Future Value)** one year from now.  
The **discount rate** (e.g. due to inflation) is **10% (r)**.  
What is the **Present Value (PV)**?

### ✅ **Solution:**

PV=FV(1+r100)n\text{PV} = \frac{FV}{(1 + \frac{r}{100})^n}PV=(1+100r​)nFV​ PV=1100(1+10100)1=11001.1=1000\text{PV} = \frac{1100}{(1 + \frac{10}{100})^1} = \frac{1100}{1.1} = \boxed{1000}PV=(1+10010​)11100​=1.11100​=1000​

### 🧠 What This Means:

* If you expect to **receive $1,100 next year**, its **actual value today** is **$1,000**.
* This is because **money loses value over time** due to factors like **inflation** or **opportunity cost**.

## 💡 **Definition: Discount Rate**

**Discount Rate** is the **interest rate** used to calculate the **present value** of expected future **benefits and costs**.

### 🔎 In Simple Terms:

It's how much **less future money is worth today** due to:

* 📈 Inflation
* 📉 Risk
* 💸 Opportunity cost of tying up money

### 🎓 Memory Tip:

“**PV tells you what future money is worth today.**  
A higher discount rate → **lower** present value.”

# 📈 **Internal Rate of Return (IRR)**

🎯 **Goal:** Help choose the most profitable project by factoring in both cash flows and time.

## 🔍 What is IRR?

**IRR is the discount rate** that makes the **Net Present Value (NPV) = 0**.

In simple words:

* It’s the rate at which your investment **breaks even** in today’s value terms.
* It’s the **maximum interest rate** a project can handle before becoming unprofitable.

### 📌 **IRR Formula (Conceptually):**

There’s no direct formula — IRR is the **value of "r"** that solves:

NPV=∑Cash Inflowt(1+r)t−Initial Investment=0\text{NPV} = \sum \frac{Cash\ Inflow\_t}{(1 + r)^t} - \text{Initial Investment} = 0NPV=∑(1+r)tCash Inflowt​​−Initial Investment=0

🔧 Usually solved using:

* Excel =IRR(...)
* Financial calculator
* Software tools

## ✅ **Decision Rule:**

| **Situation** | **Action** |
| --- | --- |
| IRR > Required Rate of Return | ✅ Accept the Project |
| IRR < Required Rate of Return | ❌ Reject the Project |

## 📚 Example:

### 🧪 Problem:

You have two projects:

* Project A: IRR = 15%, Duration = 5 years
* Project B: IRR = 10%, Duration = 1 year

**Which project do you choose?**

### 🎯 **Answer: Project A**

**Why?**  
IRR **already accounts for time** and cash flow spread.  
Higher IRR → **Better return**, even if the project is longer.

### 🧠 Key Learning:

“**Choose the project with the higher IRR**, regardless of project duration — because **time is already factored in.**”

## 📝 Summary Table

| **Concept** | **IRR** |
| --- | --- |
| Definition | Rate at which NPV = 0 |
| Used For | Project comparison, investment decision |
| Rule | Choose project with **higher IRR** |
| IRR vs Duration | Duration doesn’t affect decision since IRR includes time value |

## 💬 Interview-Ready Answer:

“IRR helps evaluate investment profitability. I prefer projects with higher IRR because it means better return over time, and time is already considered in the IRR calculation. For instance, between a 15% IRR project over 5 years and a 10% IRR project over 1 year, I’d pick the 15% one.”

# 💰 **Payback Period & Life Cycle Cost (LCC)**

🎯 **Objective:** Understand how to evaluate projects based on investment recovery and total cost over time.

## ⏱️ **Payback Period**

### ❓ What is it?

Time it takes to **recover the initial investment** from the cash inflows of the project.

🧮 **Formula (Simple):**

Payback Period=Initial InvestmentAnnual Cash Inflow\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Cash Inflow}}Payback Period=Annual Cash InflowInitial Investment​

🔍 **Important Points:**

* **Does NOT consider time value of money (no discounting)**.
* Used for **quick risk assessments**.
* Simpler than IRR or NPV.

### ✅ **Project Selection Rule:**

**Choose the project with the shorter payback period.**

### 📚 Example:

| **Project** | **Investment** | **Payback Period** |
| --- | --- | --- |
| A | $500,000 | 3 years |
| B | $300,000 | 5 years |

**✅ Choose Project A**, even though it costs more — it **recovers the investment faster**.

### 🧠 Key Takeaway:

“Smaller payback period = faster return of investment = less financial risk.”

## 💸 **Life Cycle Cost (LCC)**

### ❓ What is it?

**Total cost** of owning and operating a product/system over its **entire lifespan**.

### 🧾 Includes:

* ✅ **Direct Costs:** Purchase price, installation, materials
* ✅ **Indirect Costs:** Maintenance, training, downtime
* ✅ **Recurring Costs:** Repairs, energy use, operations

### ✅ **Project Selection Rule:**

If two projects have the **same investment**, pick the one with the **lower Life Cycle Cost**.

### 📚 Example:

| **Project** | **Investment** | **Life Cycle Cost** |
| --- | --- | --- |
| A | $100,000 | $300,000 |
| B | $100,000 | $270,000 |

**✅ Choose Project B** → lower total cost over time, **better long-term value**.

## 🔁 Payback vs Life Cycle Cost – At a Glance

| **Feature** | **Payback Period** | **Life Cycle Cost (LCC)** |
| --- | --- | --- |
| Focus | Speed of cost recovery | Total cost over entire life |
| Uses Time Value? | ❌ No | ✅ Often includes discounted costs |
| Used For | Risk reduction, short-term | Long-term budgeting, sustainability |
| Best Project? | Lower payback period | Lower life cycle cost |

## 💬 Interview-Ready Answer:

“The payback period helps identify how quickly a project recovers its cost, making it useful for risk-focused decisions. Life Cycle Costing looks at the total cost across the full life of the product. For example, I would choose a project with a faster payback to reduce financial risk, or a lower LCC if long-term cost matters more.”

# 💵 **Benefit Cost Ratio (BCR)**

🎯 **Purpose:** Helps compare the value received from a project against the cost invested.

## ✅ **What is BCR?**

**BCR = Total Benefits / Total Costs**

Think of it as:

BCR=Revenue or PaybackTotal Cost\text{BCR} = \frac{\text{Revenue or Payback}}{\text{Total Cost}}BCR=Total CostRevenue or Payback​

### 📌 **Decision Rule:**

| **BCR Value** | **Meaning** | **Action** |
| --- | --- | --- |
| BCR > 1 | ✅ Benefits > Costs → Profitable | Select the project |
| BCR = 1 | 😐 Break-even | Neutral decision |
| BCR < 1 | ❌ Costs > Benefits → Loss expected | Reject the project |

## 📚 **Example:**

| **Project** | **Investment** | **BCR** | **Decision** |
| --- | --- | --- | --- |
| A | $500,000 | 2.5 | ✅ Select A |
| B | $300,000 | 1.5 | ❌ Not selected |

**✅ Choose Project A**  
👉 Even though it has a higher investment, **it gives more return per dollar spent**.

## 💬 Interview-Ready Insight:

“BCR helps assess if a project is financially worthwhile. I’d choose the one with the higher BCR, even if the investment is higher. For instance, a project with a BCR of 2.5 gives $2.50 in return for every $1 spent — clearly better than a project with 1.5.”

## 🧠 Key Takeaways:

* **BCR focuses on efficiency** – How much benefit per unit cost?
* Investment size does **not affect** the decision alone — BCR is the priority.
* BCR is useful for **project prioritization**, budgeting, and cost justification.

## 📝 Bonus Formula Reference:

**Benefit / Payback / Revenue** =  
→ **Cost + Profit incurred**  
→ or **Cost – Loss avoided**

## 🔁 BCR vs Payback vs IRR (Quick Summary)

| **Metric** | **Tells You** | **Choose When** |
| --- | --- | --- |
| **BCR** | Value per $ spent | You want ROI efficiency |
| **Payback** | Time to recover cost | You want quick returns |
| **IRR** | Interest-like return rate | You compare profitability over time |

# **Opportunity Cost & Sunk Cost**

## 🔁 **Opportunity Cost**

### ❓ What is it?

The value of the **next best alternative** that is **forgone** when a decision is made.

### 💭 **Think of it as:**

“What am I giving up by choosing this option?”

### 🧮 **Formula:**

Opportunity Cost=NPV of the next best option not chosen\text{Opportunity Cost} = \text{NPV of the next best option not chosen}Opportunity Cost=NPV of the next best option not chosen

### 📚 **Example:**

| **Project** | **NPV** |
| --- | --- |
| A | $1,000 |
| B | $800 |

🔹 If you select **Project A**, you **lose the opportunity** to earn $800 from **Project B**.

✅ **Opportunity Cost = $800**

### ✅ **Decision Rule:**

* **Include opportunity cost** in decision-making to ensure you're selecting the **highest-value option**.
* It helps identify the **true cost of choosing** one alternative over another.

## 🚫 **Sunk Cost**

### ❓ What is it?

Money already spent that **cannot be recovered** and **should not affect** future decisions.

### 💭 **Think of it as:**

“It's gone. Don’t chase it.”

### 📚 **Example:**

* You’ve spent **$10,000** developing a software prototype.
* Later, you find a better product already exists in the market.

✅ **The $10,000 is a sunk cost** — don't let it influence the decision to continue or stop the project.

### ✅ **Decision Rule:**

**Ignore sunk costs** during project selection or continuation.  
Only consider **future costs and benefits**.

## 🔁 Quick Comparison

| **Factor** | **Opportunity Cost** | **Sunk Cost** |
| --- | --- | --- |
| Type of Cost | Potential/Hidden | Already incurred |
| Affects Decisions? | ✅ Yes | ❌ No |
| Time Frame | Future-focused | Past-focused |
| Example | Lost profit from next best option | R&D already spent |

## 🧠 Interview-Ready Insight:

“Opportunity cost shows what I give up when choosing a project — it ensures I go for the most valuable option. Sunk cost is money already gone — I make sure not to let past spending bias future decisions.”

# 💡 Opportunity Cost & Sunk Cost – Real Example

### 🧪 **Scenario:**

You have two project choices:

* 🔷 **Project A**
  + Original Budget = $1,000
  + Already Spent = $800 (**Sunk Cost**)
  + Cost to Finish = **$500**
* 🔶 **Project B**
  + Total Cost = **$1,200**

### ❓ **Which project should you select?**

## 🔍 Step-by-Step Thinking:

### 1️⃣ Ignore Sunk Cost

Already spent **$800** on Project A?  
**Forget it**! Sunk cost doesn’t count in decision-making.

### 2️⃣ Compare Remaining Costs:

| **Project** | **Relevant Cost to Finish** |
| --- | --- |
| Project A | $500 |
| Project B | $1,200 |

✅ **Select Project A** → because it needs **less money to complete**.

## 🎓 Key Concepts Recap:

| **Term** | **Meaning** |
| --- | --- |
| **Sunk Cost** | Money already spent → Can’t be recovered → **Ignore it** |
| **Opportunity Cost** | What you give up by choosing one option over another |

## 🧠 Interview-Ready Quote:

“I understand that sunk costs shouldn’t affect future decisions. In this example, even though $800 is already spent, I compare the remaining cost to finish. Since Project A needs only $500 versus $1,200 for B, I’d choose A.”

## ✅ Golden Rule:

**“Make decisions based on future costs and benefits only — never based on past spend.”**