Supply Chain Unveiled

Mid Term Evaluation

Kumar Shubham

Bhavya Chauhan

Vaishali Kamath

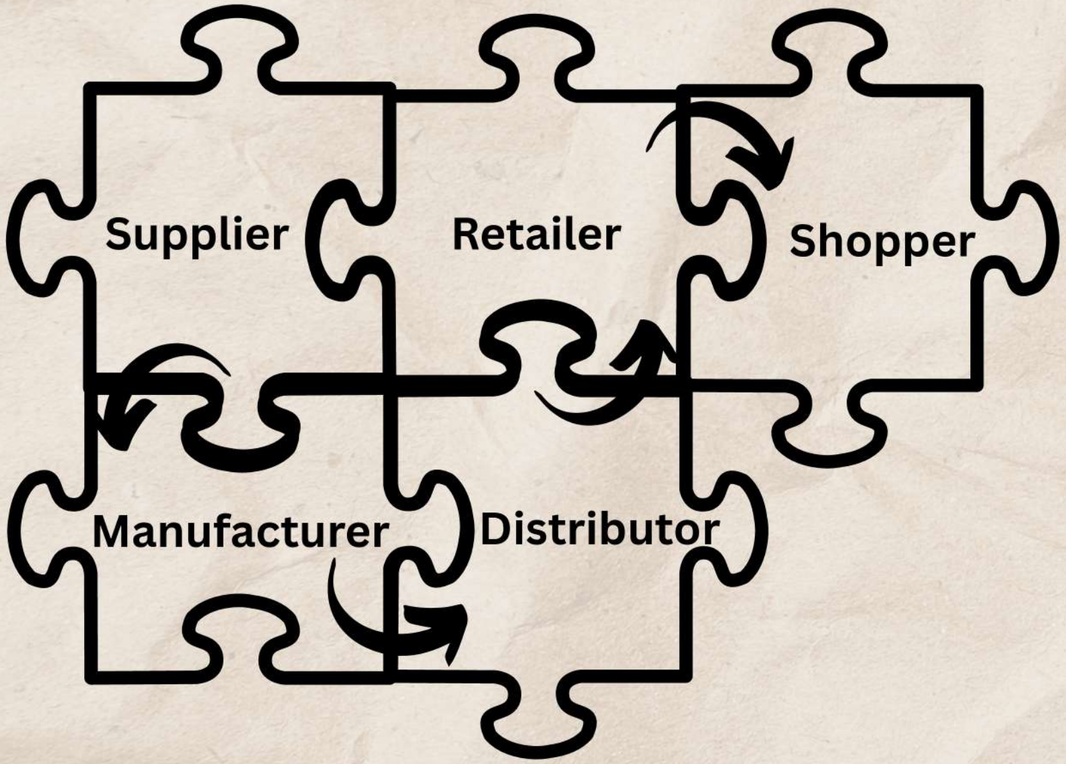
Shubh Tandon

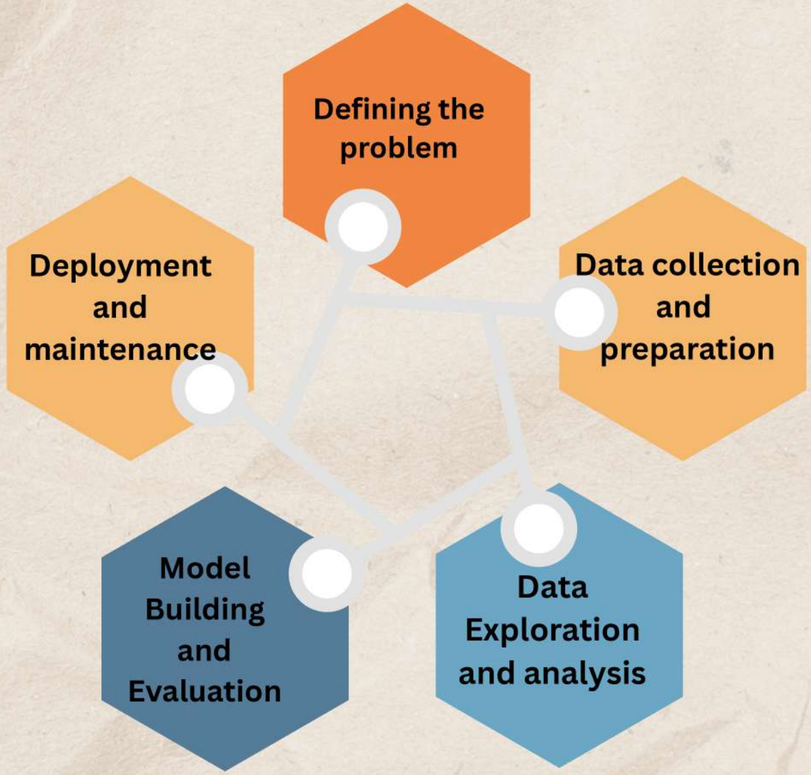
PROJECT TIMELINE

1st Meet	Basics of linear regression, cost function, MSE, Gradient Desecnt	
2nd Meet	Correlation, Data Preprocessing, Logistic Regression, K-means Clustering	
3rd Meet	Basics of consulting, MECE principle, SWOT analysis, Pestel principles, Market Sizing	ASSIGNMENT 1
4th Meet	Lasso regression, Ridge regression, PCA, Decision trees	ASSIGNMENT 2
5th Meet	Intro to Supply chain, Supply chain process & models and Key takeaways	ASSIGNMENT 3

INTRODUCTION

This project explores the depths of a supply chain, through insightful consulting sessions and note worthy DS problems to equip us with the required details of what a real world supply chain looks like.





Why this project?

To bridge the class learnings with real world analysis

First Meet

What Is ML?

Machine Learning is a subset of AI which provides us stastical tools to analyze, visualize, forecast and predict data

Types of ML

Supervised Learning

The model is trained on labeled data to learn input-output mapping and predict outcomes on new, unseen data.

Unsupervised Learning

The model is trained only on input data to discover patterns, groupings, or structure without known output labels.

Semi supervised Learning

The model where both labeled and unlabeled data are provided, allowing the model to generalize better while requiring fewer labeled examples.

Linear Regression

Linear regression is a type of supervised learning model that finds relationship between a dependent variable and one or more independent variables by fitting a straight line to the data.

Maths behind it

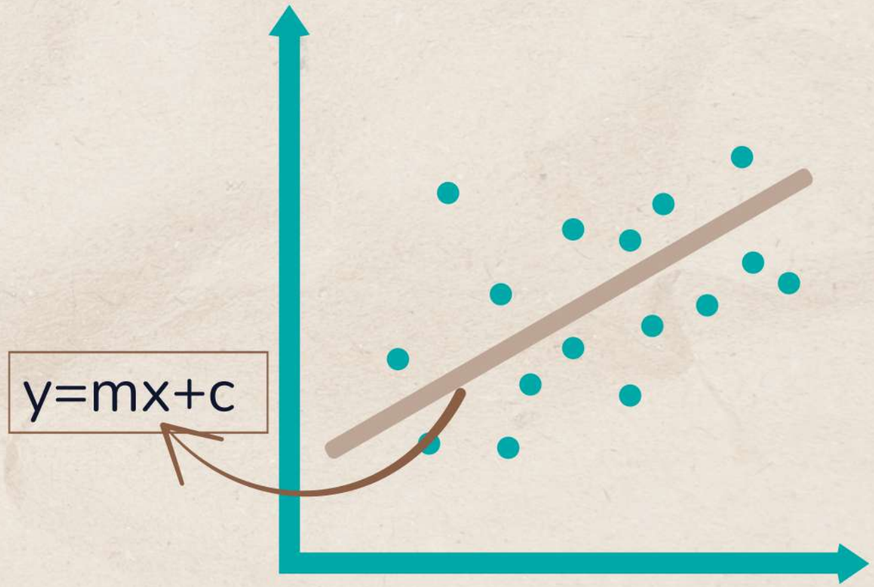
To find the best-fitting line y=mx+c, we minimize the Mean Squared Error (MSE):

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - (mx_i + c))^2$$

The optimal values of mmm and ccc are calculated using:

$$m = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2}, \quad c = \bar{y} - m\bar{x}$$

This ensures the line passes through the trend of the data with minimum error.



Mean Squared Error

Mean Squared Error (MSE) is a loss function used to measure how well a regression model is performing. It quantifies the difference between the predicted values and the actual values.

Use in Machine Learning

- Used in regression models like Linear Regression, Ridge, Lasso, etc.
- Minimized during training using optimization algorithms like Gradient Descent.
- Helps evaluate how well the model fits the data.

$$\textbf{MSE} = \frac{\sum (\hat{y}-y)^2}{n}$$

y = Actual Value

$\hat{y}$ = Predicted Value

n = no. of data points

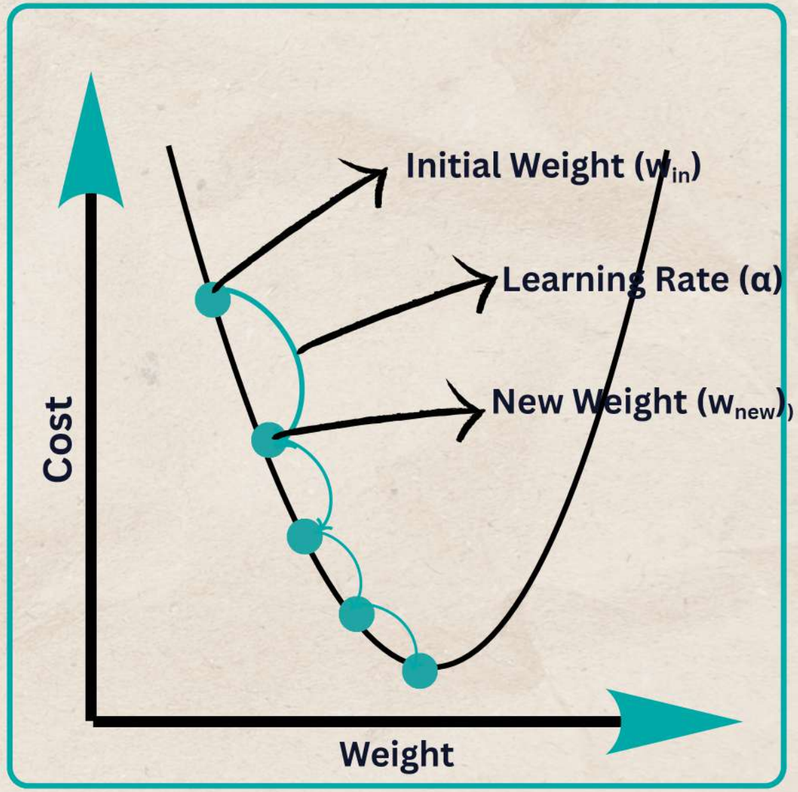
Gradient Descent

Gradient Descent is an optimization algorithm used to minimize a cost function in machine learning and deep learning. It helps us find the best parameters that result in the least possible error.

$$W_{new} = W_{in} - \alpha \, \partial c / \partial w$$

Gradient descent is used to train models by minimizing their loss functions, such as:

- Linear Regression → minimize MSE (mean squared error)
- Logistic Regression → minimize cross-entropy loss



Second Meet

CORRELATION

Correlation is a key statistical concept that researchers employ to analyze connections within their data. It helps us to Understand the relationship Between Variables

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Where,

r = Pearson Correlation Coefficient

x_i = x variable samples

y_i = y variable sample

$\bar{x}$ = mean of values in x variable

$\bar{y}$ =mean of values in y variable

$$r_s = 1 - \frac{6\sum D^2}{n\left(n^2 - 1\right)}$$

Limitations

Correlation Does Not Imply Causation - Machine learning models might pick up on spurious correlations—patterns that appear significant in the data but have no causal relationship.

Only Captures Linear Relationships - Machine learning models often deal with complex, non-linear patterns. Relying on correlation might lead you to miss important features.

Why Correlation ?

- **Reduce Bias**
- **Interpretability and Debugging**
- **Feature selection**
- **Multicollinearity**

DATA PREPROCESSING

Handling Missing Values

- **Imputation**
- **Deletion**

Additional Techniques

- **Outlier detection**
- **Feature Selection**

Data Preprocessing

Data Preprocessing in Machine Learning is the **process of transforming raw data** into a **clean and usable format** before feeding it into a **machine learning** mode

Scaling Features

- **Normalization**
- **Standarization**

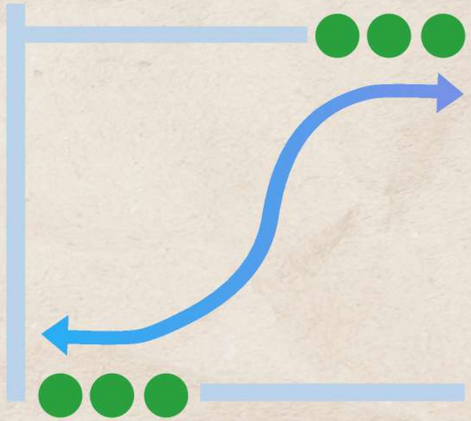
3 **Enconding Critical Variables**

- **One-hot Coding**
- **Label enconding**

LOGISTIC REGRESSION

- Logistic Regression **predicts** the **probability** that a given input belongs to a certain class.
- To get this probability, **we use** a special **function** called the **sigmoid function.**

$$S(t) = \frac{1}{1 + e^{-t}}$$



Cost - Function

A cost function (also known as a loss function) measures the error between the actual values (ground truth) and the predicted values by a model.

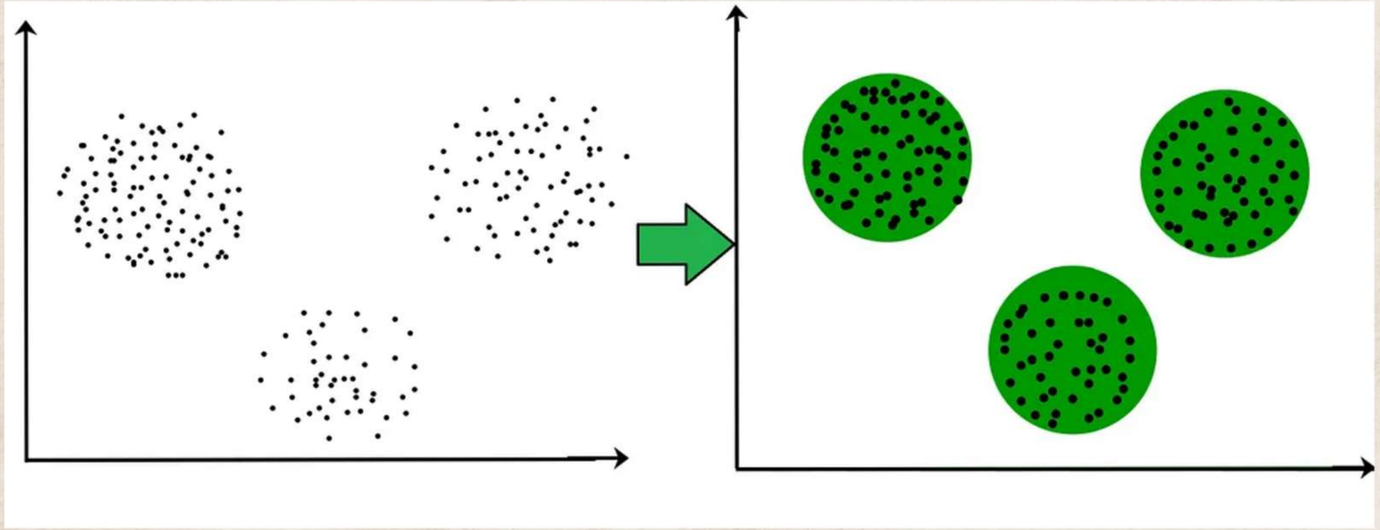
$$J = -\sum_{i=1}^{m} y_i \log\left(h_\theta\left(x_i\right)\right) + \left(1 - y_i\right) \log\left(1 - h_\theta\left(x_i\right)\right)$$

Log Loss penalizes incorrect predictions more effectively than MSE and helps the model learn to improve. **It works by taking the logarithm of predicted probabilities.**

Where:

- **m is the number of training examples**
- **y_i is the true class label for the i-th example (either 0 or 1).**
- **$h_\theta(x_i)$ is the predicted probability for the i-th example, as calculated by the logistic regression model.**
- **θ is the model parameters**

K MEANS CLUSTERING



It is a **centroid-based algorithm**, where each **cluster is associated with a centroid**. The main aim of this algorithm is to **minimize** the **sum of distances between the data point and their corresponding clusters.**

Formation Of Clusters

Number of Clusters or Number of Centroids

1. **Select** the **number K** to decide the **number of clusters.**
2. **Select random K points or centroids.** (It can be other from the input dataset).

Averaging the data for finding the centroid

$$A = \frac{1}{n}\sum_{i=1}^{n} a_i = \frac{a_1 + a_2 + \cdots + a_n}{n}$$

Each coordinate of the **centroid** is the **arithmetic mean** of the corresponding coordinates **of all points in the cluster**.

Formation of clusters (groups) based on certain similarities.

1. **Assign each data point** to their **closest centroid**, which will form the predefined K clusters.
2. **Repeat** the step, which **means reassigning each data point** to the **new closest centroid** of each cluster.

Third Meet

What is Consulting?

'doctors* for *businesses'

Consulting is defined as the practice of **providing a third party with expertise** on a matter in exchange for a fee. The consulting industry consists of **six main functional areas**: Strategy Consulting, Management Consulting, Operations Consulting, HR Consulting, Financial Advisory and IT Consulting.

Key Components of being a consultant–

- **Define the problems** or opportunities their businesses face,
- Collect and **analyse data** to better understand the problem/opportunity and identify a recommended course of action, and
- Plan the **implementation** of that solution across the company.

Tools like ***machine learning*** and strategic consulting ***frameworks*** are used to reach optimised solutions

FRAMEWORKS

Decision frameworks offer a clear, **step-by-step** approach to decision-making, helping to avoid bias and ensure all relevant factors are considered.
They help consultants and clients **break down complex issues into smaller**, more manageable parts, making it easier to understand and address them.

Following are three of the major frameworks used widely during problem solving -

- **MECE Principle**
- **SWOT Analysis**
- **PESTEL Principle**

MECE Principle

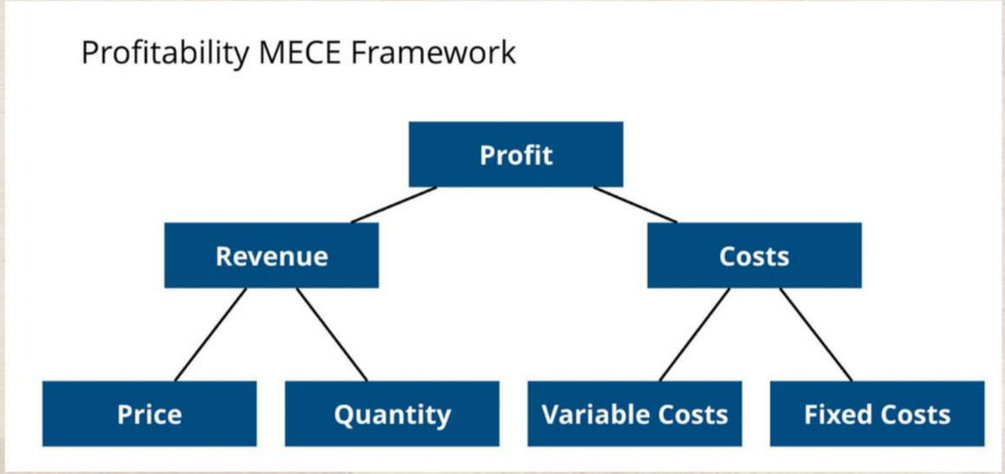
MECE is about organising information or ideas into categories that are:

1. *Mutually Exclusive*: **No overlap** between categories
2. *Collectively Exhaustive*: **All possibilities** are covered

MECE is *valuable because* it helps you:

- **Break down complex problems** into manageable parts
- Ensure you're considering **all relevant factors**
- **Avoid redundancy and gaps** in your thinking

EXAMPLE - 1



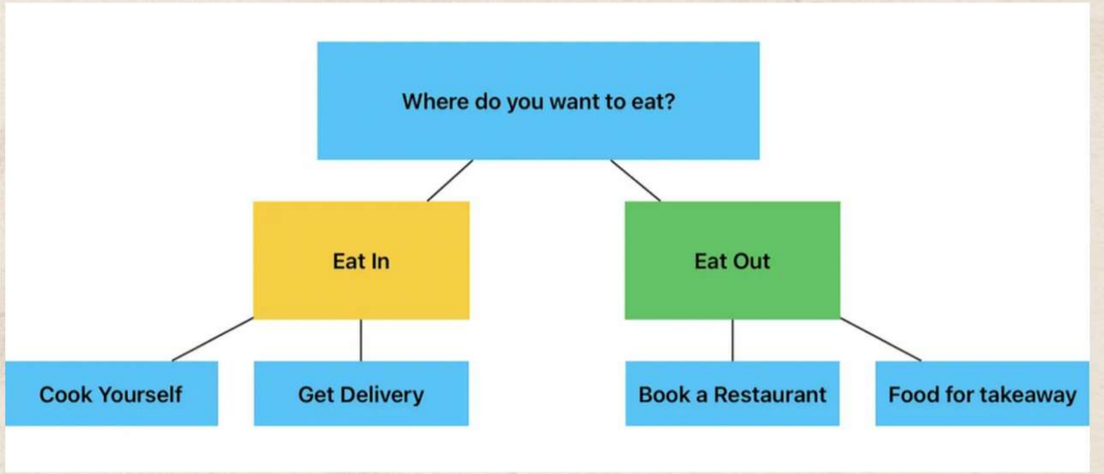
FORMULAS USED:

PROFIT = REVENUE – COSTS

REVENUE = QUANTITY * PRICE

COSTS = VARIABLE COSTS + FIXED COSTS

EXAMPLE - 2



SWOT ANALYSIS

Strengths

- Loyal customer base
- Unique technology

Weaknesses

- High costs
- Weak online presence

Opportunities

- New technology
- Customer lifestyle changes

Threats

- New competitors
- Rising raw material costs

PESTEL PRINCIPLE

Political	Government influence and policies
Economic	Economic conditions and trends
Social	Cultural, societal, and demographic trends
Technological	Impact of technology and innovation
Environmental	Ecological and environmental aspects
Legal	Legal environment and regulations

MARKET SIZING

Market sizing is a crucial step in understanding the **potential of a business idea**. It involves estimating the total addressable market (TAM), serviceable addressable market (SAM), and serviceable obtainable market (SOM) to determine the potential revenue and growth opportunities.

TAM = Total Addressable Market

This represents the revenue opportunity that a company has if it has a full 100% of the market share, and there is no competition. TAM represents the total revenue opportunity available for a product or service in a specific market.

SOM = Serviceable Obtainable Market

This represents the actual amount of the market that is being served by the company's products and services.

SAM = Serviceable Addressable Market

This represents the "slice" of the TAM "pie" that can be served by a company's products and services.

Fourth Meet

Lasso Regression

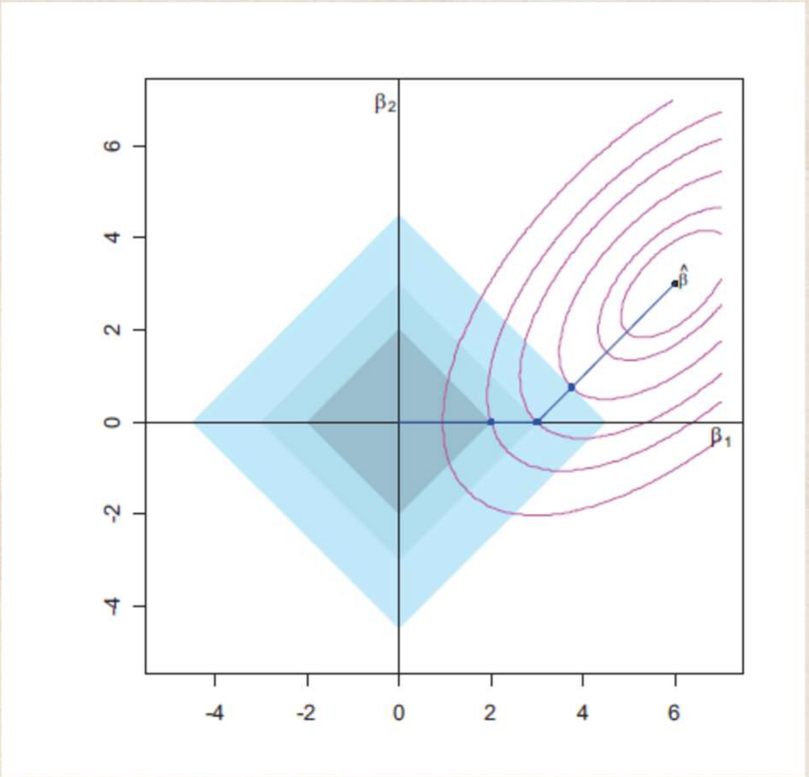
Lasso regression is a type of linear regression that adds a penalty term to reduce overfitting. It helps in feature selection by shrinking less important feature coefficients to zero.

Maths behind it –

$$\text{SS} = \sum (y_i - \hat{y}_i)^2 + \lambda \sum |w_i|$$

Lasso minimizes the following cost function:

- The first term is the Mean Squared Error (MSE)
- The second term is the L1 penalty, where λ controls the amount of shrinkage
- Larger λ values → more coefficients become zero



Ridge Regression

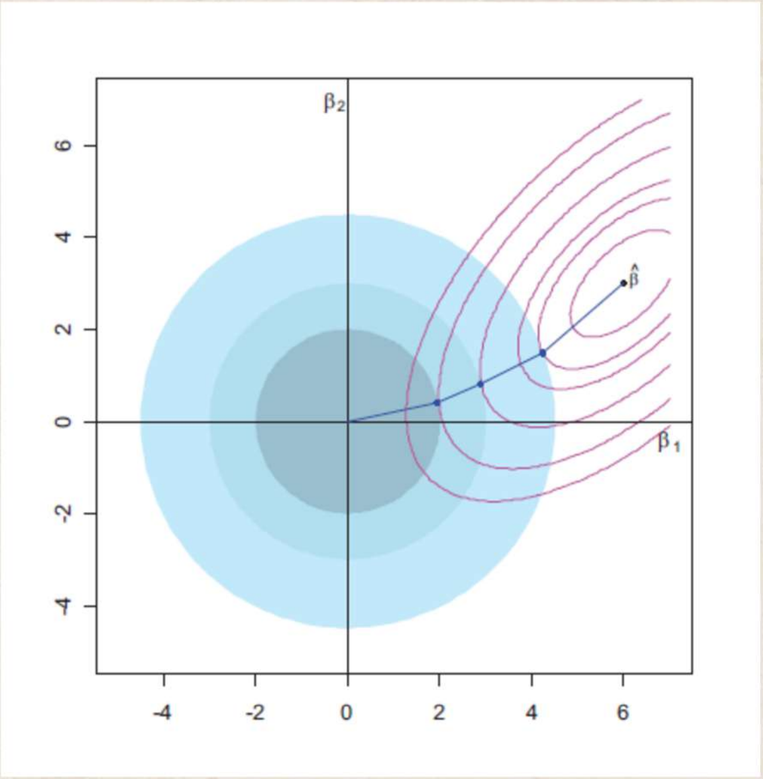
Ridge Regression is a linear regression technique that adds L2 regularisation to the loss function. It helps reduce overfitting by shrinking the model coefficients, but unlike Lasso, it does not reduce them to zero, so all features are retained.

Maths behind it –

$$\text{Loss} = \sum (y_i - \hat{y}_i)^2 + \lambda \sum w_i^2$$

Ridge minimizes the following cost function:

- The first term is the Mean Squared Error (MSE)
- The second term is the L2 penalty, where λ controls the amount of shrinkage
- Larger λ values → coefficients get smaller, but not zero



Principal Component Analysis

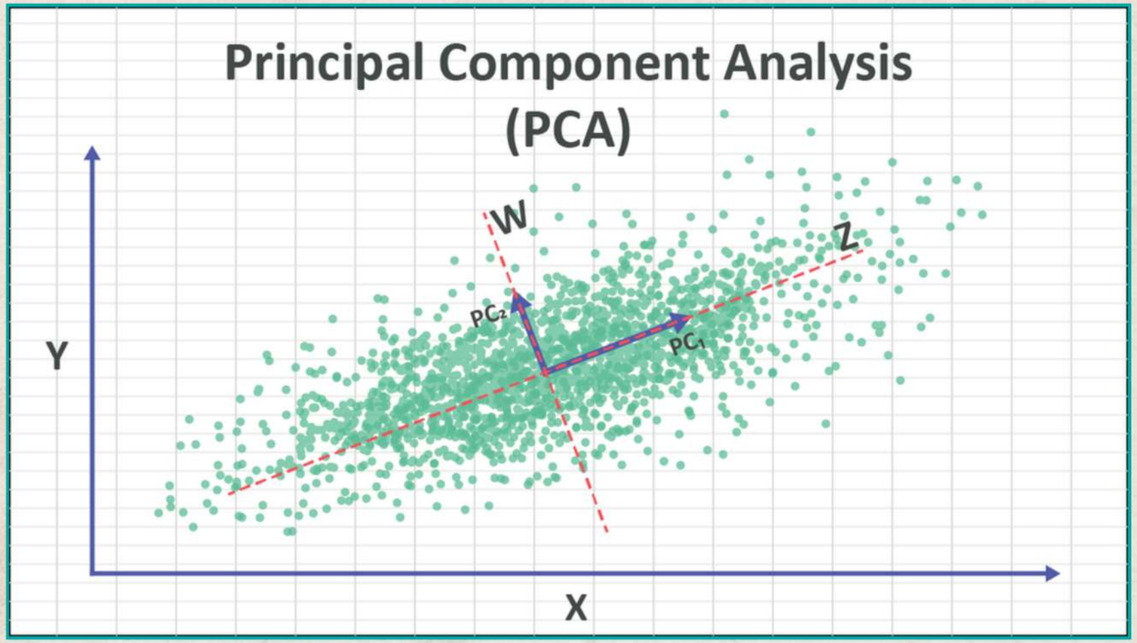
PCA is a dimensionality reduction technique used to simplify large datasets by transforming them into a smaller set of variables called principal components, while retaining most of the original variance in the data.

$$\text{Cov}(X, Y) = \frac{\sum(X_i - \bar{X})(Y_j - \bar{Y})}{n}$$

Maths behind it –

PCA works by:

- Standardizing the data
- Computing the covariance matrix
- Finding eigenvectors and eigenvalues of this matrix
- Projecting the data onto top k eigenvectors (principal components)



Decision Trees

A Decision Tree is a supervised learning algorithm used for both classification and regression tasks. It mimics human decision-making by splitting data into branches based on feature values until it reaches a decision.
It's easy to understand, visualize, and interpret.

Feature Selection

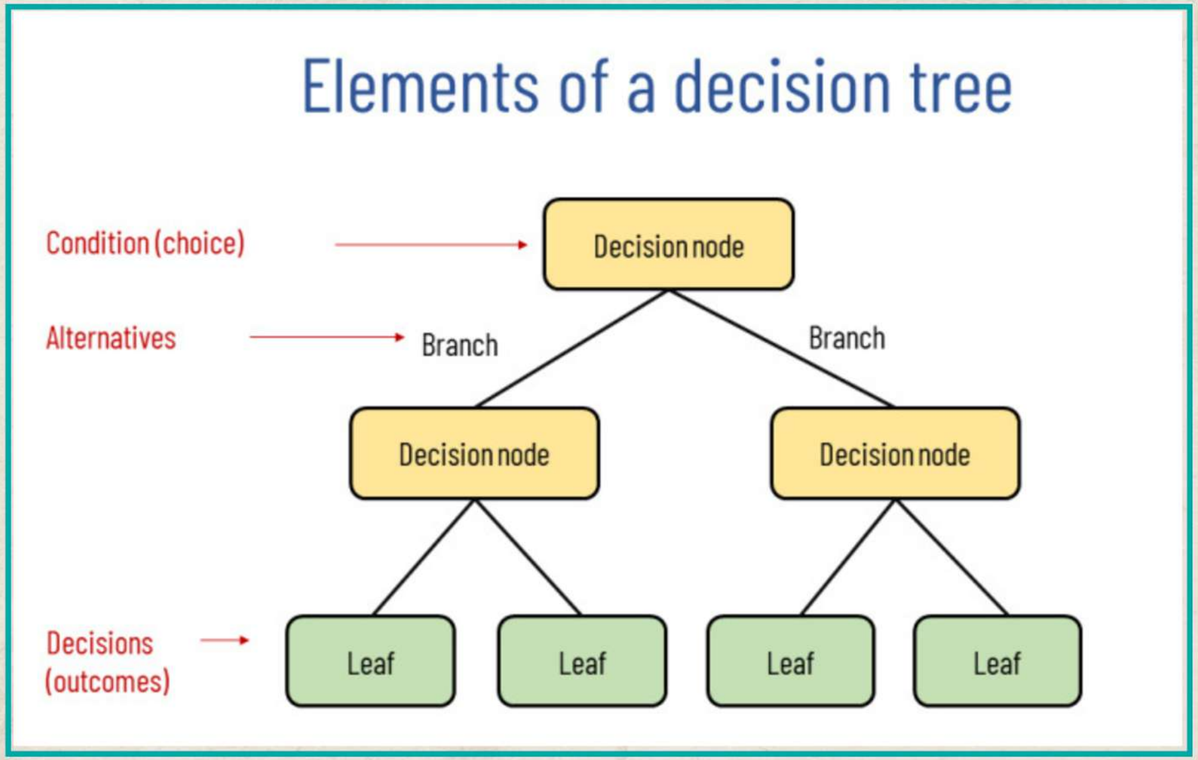
The algorithm selects the optimal feature to split the data at each node using criteria such as Gini Impurity or Information Gain, which quantifies the reduction in entropy.

Recursive Splitting

It recursively creates decision nodes and leaf nodes by partitioning the dataset based on the selected features. This process continues to refine the data subsets.

Stopping Condition

The splitting process halts when a predefined stopping condition is met, such as reaching a pure node (where all samples belong to the same class) or a maximum tree depth, preventing overfitting.



Fifth Meet

INTRODUCTION TO SUPPLY CHAIN

WHAT IS SUPPLY CHAIN?

A supply chain is the integrated system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer.

Core Functions of a Supply Chain:

SOURCING/PROCUREMENT:

Selecting and sourcing suppliers for raw materials, parts, or services.

PRODUCTION:

Manufacturing goods or executing service delivery processes.

INVENTORY MANAGEMENT

Balancing supply and demand through storage and stock control.

LOGISTICS

Transportation and warehousing to move goods effectively

DISTRIBUTION:

Ensuring the final product reaches customers through appropriate channels.

CUSTOMER SERVICE & RETURNS:

Handling delivery, feedback, after-sales service, and reverse logistics.

THE SUPPLY CHAIN PROCESS – STEP-BY-STEP

1)DEMAND FORECASTING & PLANNING

- Predict future needs using data analytics, market trends, and past demand.
- Align production and procurement with expected sales.

2)SOURCING/PROCUREMENT

- Evaluate suppliers on cost, quality, and reliability.
- Establish contracts and maintain supplier relationships

3)MANUFACTURING/PROCESSING

- Use raw materials to produce goods or deliver services
- Ensure efficiency, quality control, and cost-effectiveness

4)INVENTORY MANAGEMENT

- Maintain optimal stock levels (e.g., Just-In-Time systems).
- Avoid both shortages and overstocking.

5)LOGISTICS

- Plan transport routes, select carriers, and ensure timely delivery
- Includes both inbound (from suppliers) and outbound (to customers) logistics.

6)DISTRIBUTION & FULFILLMENT

- Deliver goods via wholesalers, retailers, or directly to consumers.
- Use physical stores, online platforms, or hybrid models.

7)RETURNS & REVERSE LOGISTICS

- Manage damaged, unused, or end-of-life products
- Recover value through recycling, refurbishing, or disposal

TYPES OF SUPPLY CHAIN MODELS

Efficient Supply Chain

Focus: Cost minimization, standardized processes, lean inventory
Best For: Stable markets, price-sensitive products
Example: Mass manufacturing

Fast Supply Chain

Focus: Speed to market, quick turnover
Best For: Trend-driven or seasonal goods
Example: Fashion or tech gadgets

Continuous Flow Supply Chain

Focus: Constant production flow and consistent supply
Best For: Mature industries with steady demand
Example: Food, pharma

Agile Supply Chain

Focus: Flexibility, quick response to demand changes
Best For: Custom, unpredictable, or high-variety demand
Example: High-end electronics, specialty goods

Custom-Configured Supply Chain

Focus: Tailored products through a mix of agile and continuous
Best For: Build-to-order models
Example: Modular furniture, custom vehicles

Key Takeaways from the Supply Chain Study:

- A supply chain is not linear — it's a network of interdependent activities and players.
- Each function, from planning to delivery, plays a role in customer satisfaction.
- The choice of supply chain type must align with business goals, market dynamics, and customer expectations.
- Technologies like AI, IoT, and blockchain are increasingly important in managing modern supply chains.
- Sustainable and resilient supply chains are gaining importance due to environmental and geopolitical concerns.

Final Insight:

Understanding supply chains gives us a behind-the-scenes view of how businesses work — showing how products/services reach us through a series of complex, well-orchestrated steps.

SUPPLY CHAIN ANALYSIS IN DIFFERENT SECTORS

Supply chains are complex and dynamic — priorities can shift depending on timelines and stages.

Manufacturing requires precise planning around sourcing, timing, and methods to ensure efficiency.

Quality control is key in later stages to reduce defects and ensure product reliability.

Internal supply chains are often opaque — simulating one through role-play helps understand it practically.

Simulating supply chains through role-based group exercises helps build practical understanding.

SESSION BY
MOHIKA AGRAWAL
Y21 , EX EX LEADER ICG

Luxury Fashion: Backend (procurement, manufacturing) drives demand — key for brands like LV & Chanel.

E-Commerce: Amazon/Meesho rely on wide warehousing; Meesho excels with low-cost efficiency.

Quick Commerce: Blinkit thrives via micro-fulfilment and ultra-fast delivery

Makeup: MAC imports (Canada), Lotus sources locally — affects cost vs. appeal.

FMCG: ITC & HUL's vast portfolios make supply chains complex to analyze.

ASSIGNMENT

CONSULT

TASK 1

ESTIMATING DAILY ENERGY & RESOURCE CONSUMPTION AT A REFUGEE CAMP IN SPAIN

Estimate the daily energy and resource consumption at a refugee camp in Spain during the summer. The camp consists of 10 housing blocks, each structured as a 5-room house with one kitchen. The camp is at 80% occupancy. Spend the entire day inside the camp, cooking three meals a day, and using electricity, water, and gas .

TASK 2

MARKET ANALYSIS FOR A FRAGRANCE COMPANY

Conduct a market analysis for a fragrance company. Your goal is to estimate the potential market size and identify growth opportunities.
1. **TAM SAM SOM**. 2. Unit Economics: Estimate the average price of a fragrance bottle. Calculate the cost of manufacturing and marketing a fragrance bottle.
Bonus:Create a **catchy name** and **tagline** for the fragrance company.

TASK 3

COMPARATIVE SUPPLY CHAIN ANALYSIS

Choose any two companies from the same sector and your task is to **research the supply chain** of the two selected companies in **as much depth as possible**. Identify and analyze the **similarities and differences** in their supply chain strategies, structures, technologies and practices.

DATA SCIENCE

TASK 1

PREDICTING UNITS SOLD USING REGRESSION ON FASHION SHIPMENT DATA

A fashion company wants to improve its demand forecasting. You are given a dataset of past shipments. Based on features like manufacturing cost, shipping cost, weight, and other batch metadata, build a model to predict units sold.

TASK 2

WAREHOUSE SEGMENTATION USING K-MEANS

A fashion company wants to cluster warehouses based on their product intake patterns to identify regional or functional similarities.

DATA SCIENCE TASK 1

PROBLEM STATEMENT OVERVIEW

The task involves building a regression model to predict the number of units sold for each shipment using historical shipment data.

OBJECTIVE - Train and evaluate multiple regression models using these features and compare their performance based on Root Mean Squared Error (RMSE) and actual vs. predicted plots.

DATASET INCLUDES FEATURES

- MFG. COST
- SHIPPING COST
- WEIGHT
- BATCH META DATA

LEARNING OUTCOMES

Gained hands-on experience with feature selection, preprocessing, and model evaluation.

Learned how model complexity (e.g., tree-based vs. linear models) affects performance.

Became comfortable interpreting RMSE and residual plots to assess model accuracy.

TECHNIQUES & CONCEPTS APPLIED

LINEAR REGRESSION

- A fundamental algorithm that models the relationship between features and the target as a straight line
- Acts as a baseline model — good for detecting overall trend but limited if data shows non-linearity

RIDGE REGRESSION & LASSO REGRESSION

- Both are regularized linear models, designed to prevent overfitting and manage multicollinearity.
- Ridge (L2 Regularization): Shrinks coefficients but doesn't eliminate any.
- Lasso (L1 Regularization): Can shrink some coefficients to zero — hence also performs feature selection.

DECISION TREE REGRESSION

- Splits the dataset into branches using decision rules to fit a model.
- Captures non-linear relationships but may overfit.

EVALUATION METRIC

- RMSE (Root Mean Squared Error):

- Measures the square root of the average squared differences between predicted and actual values.
-Penalizes large errors more heavily.
-Lower RMSE = Better model performance.

VISUALIZATION FOR MODEL ASSESSMENT

- For each model, a scatter plot is created:

X-axis: Actual Units Sold ; Y-axis: Predicted Units Sold
-Helps visually check how close predictions are to the actuals.
- Ideal points lie along the diagonal line (Perfect Prediction Line

DATA SCIENCE TASK 2

PROBLEM STATEMENT OVERVIEW

The task focuses on applying unsupervised learning to identify clusters of warehouses with similar product intake behaviors. The goal is to group warehouses based on intake patterns to reveal regional or functional similarities.

TECHNIQUE APPLIED

- **K-Means Clustering is an unsupervised algorithm that partitions data into K distinct clusters based on feature similarity.**
- **Applied to warehouse-level product intake features to group similar warehouses.**

HYPERPARAMETERS EXPLORED

NO OF CLUSTERS

Tuned using Elbow Method and Silhouette Analysis to find the most meaningful grouping

INITIALIZATION METHOD

Compared random and k-means++ initialization to improve convergence and stability.

DISTANCE METRICS

While K-Means typically uses Euclidean distance, alternative metrics were explored through custom implementation

Elbow Method: Plots inertia vs. number of clusters; the 'elbow point' suggests optimal K.

Silhouette Score: Measures clustering quality (range: -1 to 1); higher scores = better separation.

Inertia: Sum of squared distances within clusters; lower values indicate tighter clusters.

Visualizations: Scatter plots with color-coded clusters and centroids to assess grouping.

LEARNING OUTCOMES

Understood the application of unsupervised learning in real-world scenarios where labels are unavailable.

Gained hands-on experience with K-Means Clustering and the impact of different hyperparameters (e.g., number of clusters, initialization).

Learned how to evaluate cluster quality

Improved visualization skills through scatter plots of clusters and centroids to interpret clustering outcomes.

Realized how clustering can reveal hidden patterns and groupings, aiding in better operational decisions (e.g., regional grouping of warehouses).

CONSULT TASK 1

EXPLANATION

Estimate daily usage of electricity (kWh), water (liters), and gas (liters) at a refugee camp in Spain during summer.

- The camp includes 10 housing blocks, each with 5 rooms + 1 kitchen
- Camp is at 80% occupancy
- Assumed full-day usage for cooking three meals/day and regular daily activities

DELIVERABLE

01 **Final consumption estimates for electricity, water, and gas**

02 **Clearly stated assumptions behind each estimate**

CALCULATION LOGIC

- Electricity (kWh) = Devices × Power × Time × Occupants
- Water (L) = People × Liters per person
- Gas (L) = People × Liters per person/day

LEARNING OUTCOME

1. APPLIED REAL-WORLD ESTIMATION TECHNIQUES FOR RESOURCE PLANNING UNDER DEFINED CONSTRAINTS.
2. PRACTICED LOGICAL ASSUMPTION BUILDING AND TRANSLATING QUALITATIVE INFORMATION INTO QUANTIFIABLE METRICS.
3. GAINED EXPOSURE TO SUSTAINABILITY THINKING, ESPECIALLY IN HUMANITARIAN OR CONSTRAINED SETTINGS.
4. STRENGTHENED SKILLS IN STRUCTURED PROBLEM SOLVING AND PRESENTING ESTIMATES WITH CLARITY.

CONSULT TASK 2

EXPLANATION

Conducted a market sizing and unit economics analysis for a fragrance brand.

- Defined TAM, SAM, and SOM using assumed consumer data and market scope
- Estimated average price and cost structure (manufacturing + marketing) per fragrance bottle

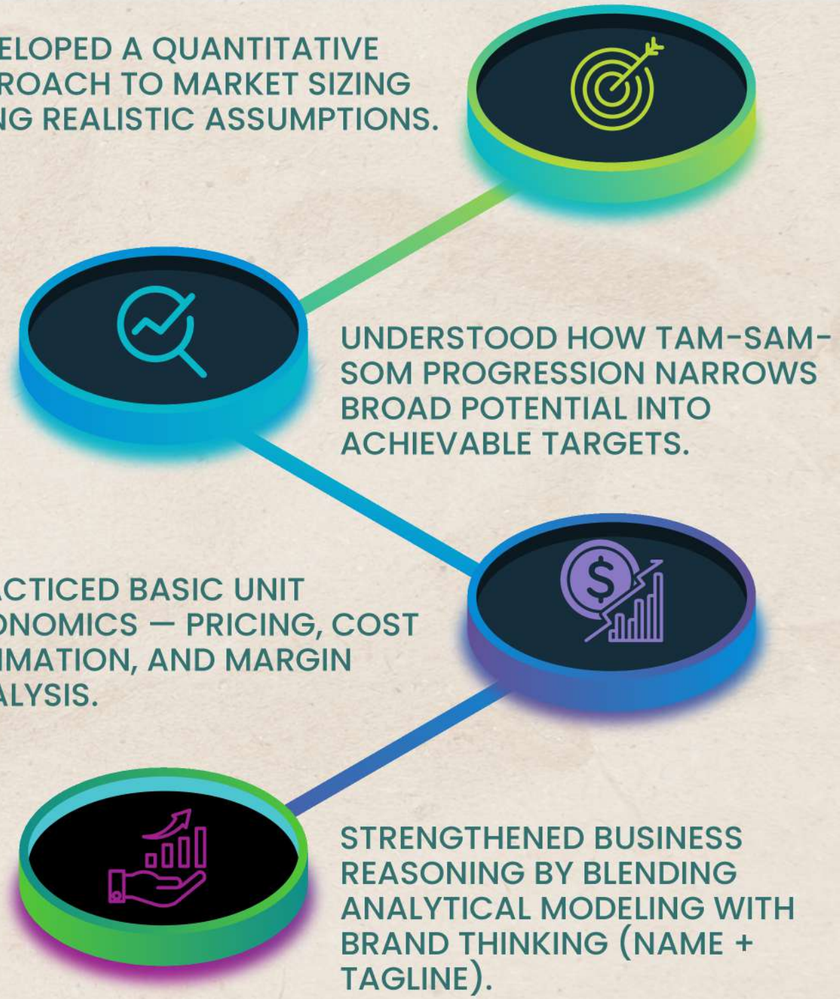
TAM SAM SOM FRAMEWORK

TAM (Total Addressable Market): The entire market demand for fragrances across all geographies and consumer segments. Helps set the upper market ceiling.

SAM (Serviceable Available Market): The portion of TAM reachable by the company based on product type, distribution, and target geography.

SOM (Serviceable Obtainable Market): The realistic market share the company can capture in the near term, based on resources, positioning, and competition.

LEARNING OUTCOME



DEVELOPED A QUANTITATIVE APPROACH TO MARKET SIZING USING REALISTIC ASSUMPTIONS.

UNDERSTOOD HOW TAM-SAM-SOM PROGRESSION NARROWS BROAD POTENTIAL INTO ACHIEVABLE TARGETS.

PRACTICED BASIC UNIT ECONOMICS — PRICING, COST ESTIMATION, AND MARGIN ANALYSIS.

STRENGTHENED BUSINESS REASONING BY BLENDING ANALYTICAL MODELING WITH BRAND THINKING (NAME + TAGLINE).

CONSULT TASK 3

EXPLANATION

We were required to form groups and select any two companies from the same sector (excluding fast fashion). The goal was to research and compare their supply chains in depth, focusing on various components like procurement, operations, logistics, and technology. The key objective was to understand how supply chain strategies vary even within the same industry, and what makes each company's approach unique.

APPROACH USED

- Performed extensive secondary research (annual reports, case studies, articles, supply chain databases)
- Created a comparison framework focusing on: **Inbound & outbound logistics** ; **Supplier relationships & sourcing strategies ; Use of technology (ERP, AI, automation) ; Inventory & warehouse management ; Sustainability practices and localization**

LEARNING

- **Understood industry-specific supply chain structures**
- **Learned how strategy differs based on company size, product type, and geography**
- **Recognized the importance of technology and sustainability in modern supply chains**
- **Improved our skills in data analysis, research, comparison**

CHOSEN INDUSTRIES & COMPANIES

01 LUXURY FASHION
LOUIS VITON & CHANEL

02 E- COMMERCE
AMAZON &B BLINKIT

03 AVIATION
INDIGO & EMIRATES

04 QUICK COMMERCE
INSTAMART & ZEPTO

05 COSMETICS
MAC & LOTUS

06 EYEWEAR
LESKART & TITAN EYE+

07 FMCG
HUL & ITC

Thank You