Micro and Macro Economics

Tags	basket consumption demand exchange macroeconomics microeconomics prices production supply survey utility
Course	BDM
# Week	1
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Micro and Macro economics

five activities of economy:

- production
- consumption
- exchange (to facilitate P and C)
- distribution (resource eg money is also moved)
- investment (saving money to consume later, should i consume now or later)

Household:

individual consumers of same family who together consume products (example FMCG) are called household

Two agent model:

- firms (producers)
- household (consumers)

Production and Consumption are in a cycle, items as well as resources (money) keep moving hands and cycles through Producers and Consumers. All the five activities go hand in hand, and any hinderance to one will stall others as well.

two models of viewing the flow of items and resources:

- in a microscopic manner, focusing on each individual or household or producer
  - how much to produce/consume
  - how to exchange
  - etc
  - this is called microeconomics
- or we can look at it in a macroscopic view, by looking at aggregates
  - example: state level, country level, global level, sector based, industry based (collection of firms) etc

We can look at all the five activities and summarise the quantities based on state, country, etc

GDP is macroeconomics, price is linking micro to macro.

where does data fit in this?

- decision making process of each individual/firm is based on a set of logics and contracts.
- Everyone has limited resources, they have to choose where and by how much to allocate it.
- To choose correct (or optimum) resource allocation we need to take correct decisions, decisions can be properly taken by using and analysing data.

- We need efficiency of the firm, etc to take correct decisions, these are only possible if we have the necessary data.

household:

- every day household makes tens or hundreds of decisions, what to consume and when
- Certain decisions are taken by using data but that data is not structured or organized, eg MRP of items and comparisons
- Certain decisions (usually big decisions) are taken by collecting, organizing, and analyzing data, example comparing stats and prices of car models to buy

data of the other

- producers also need data of consumers, to better cater to the market
- consumers need data of producers, to choose better brand of the item or item which will last longer
- typical surveys and market questionaires are an examples, but it can be limiting, especially now that we are way more connected via the internet, physical surveys fall short of the actual reach of the producer
- national level surveys also exist, example National Sample Survey Consumption Data, released by Central Statistical Office (CSO)
- market research can allow us to analyse and predict large scale trends of consumption and the economy as a whole

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notes

- economics is the study of movement of goods and resources
- it can be studied person to person, or aggregate like a region or sector
- surveys and data banks exist to facilitate decision making for firms

- data analysis also done by each firm of itself and consumers
- consumers also do data-based decision making

Production, Consumption, and Exchange

Production

- it is process of converting raw materials into useful good/services. Goods or services become useful as they acquire utility value in the process of production.
- Producers have limited capital resources while they have a wide range of goods and services to choose from for their firms and factories to produce.
- Firms have many inputs of production which make many outputs, among all of them, firms choose the one which minimizes cost and maximises profit.
- Value of goods are determined individually by each person, for someone a thing can be useless where as for other it may be valueable. It also includes the opportunity cost, as some can make it at home in exchange of their time, where as others may not have that time (that time is more valuable if spent somewhere else)
- Utility is subjective, and varies for person to person.
- to find what product has more utility value the consumers, we need lots of data and up to date data, as utility may change with time

price

- price is not only the amount you pay to acquire something
- it also coordinates the entire market
- if price goes up, the demand reduces, if it comes down, demand increases, etc

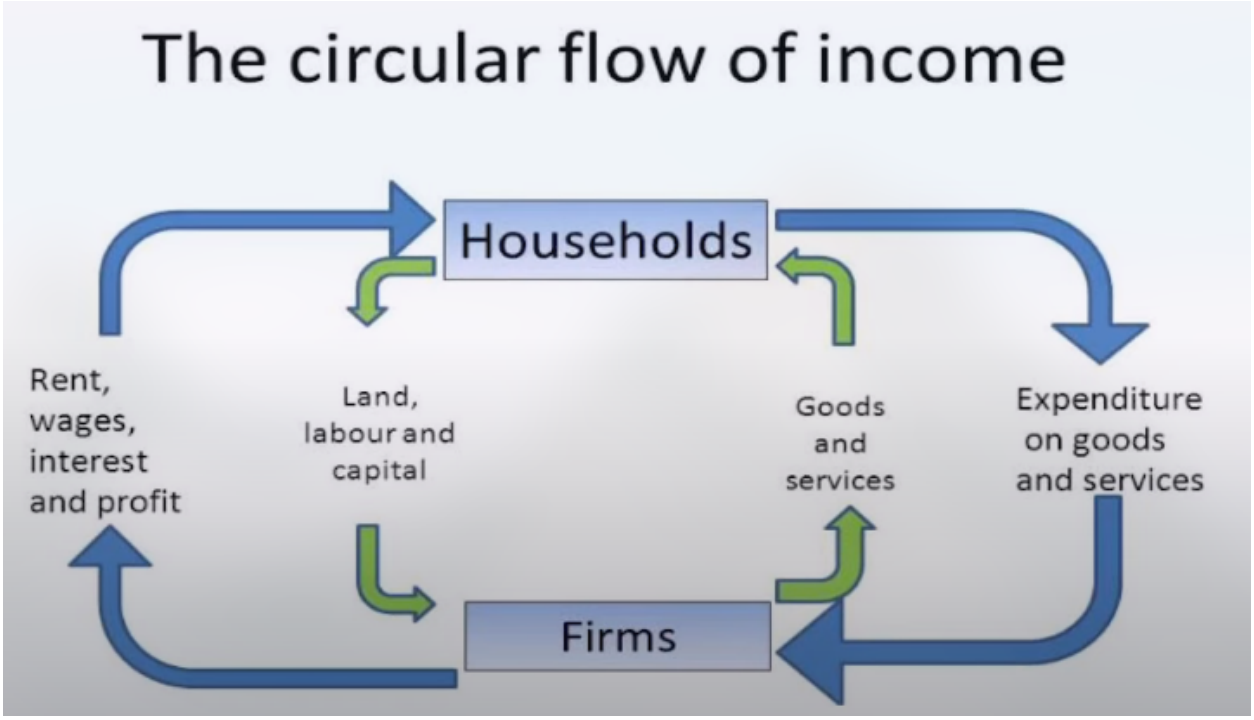
- with change in prices of raw materials, prices and volume of manufactured goods also change

Consumption

- spending resource to acquire goods with utility value to acquire satisfaction
- if there were no consumption, there would be no production
- unit of consumption is a consumer, who consumes goods and derives satisfaction from it.
- satisfaction is highly subjective, and hard to quantify, but it can be assessed via multiple means, and data collected.
- purchasing patterns of goods and similarity of items and trends in dates and times of purchase gives producers lots of data about the consumer’s purchasing decisions and predict the demand of the products.
- if producer and consumer are not in sync, that is, consumer is not buying what producer is making and producer is not making what the consumer wants, then economy will slow down, as transactions wont happen.
- any mismatch in producer and consumer results in change in prices.
- a consumer has limited income, but unlimited wants
- consumer also prioritise their **needs** and high utility products over others.
- producers are interested to study the consumer behaviour; how they utilize the limited resource they have on the unlimited choices they have, their ultimate goal is to maximise their satisfaction.
- in consumption theory, a set of standard relationships explaining how consumers tend to behave is formulated.
- data is very important for finding meaningful patterns in consumer behaviour.
- consumption theory uses data to generalize and formalize the general standard behaviour patterns of consumers.

Exchange

- exchange is circular as money travels in a closed system in loops.
- money is not created or destroyed (in most cases)
- so it has to only change hands
- flow of money and goods are usually in opposite direction.

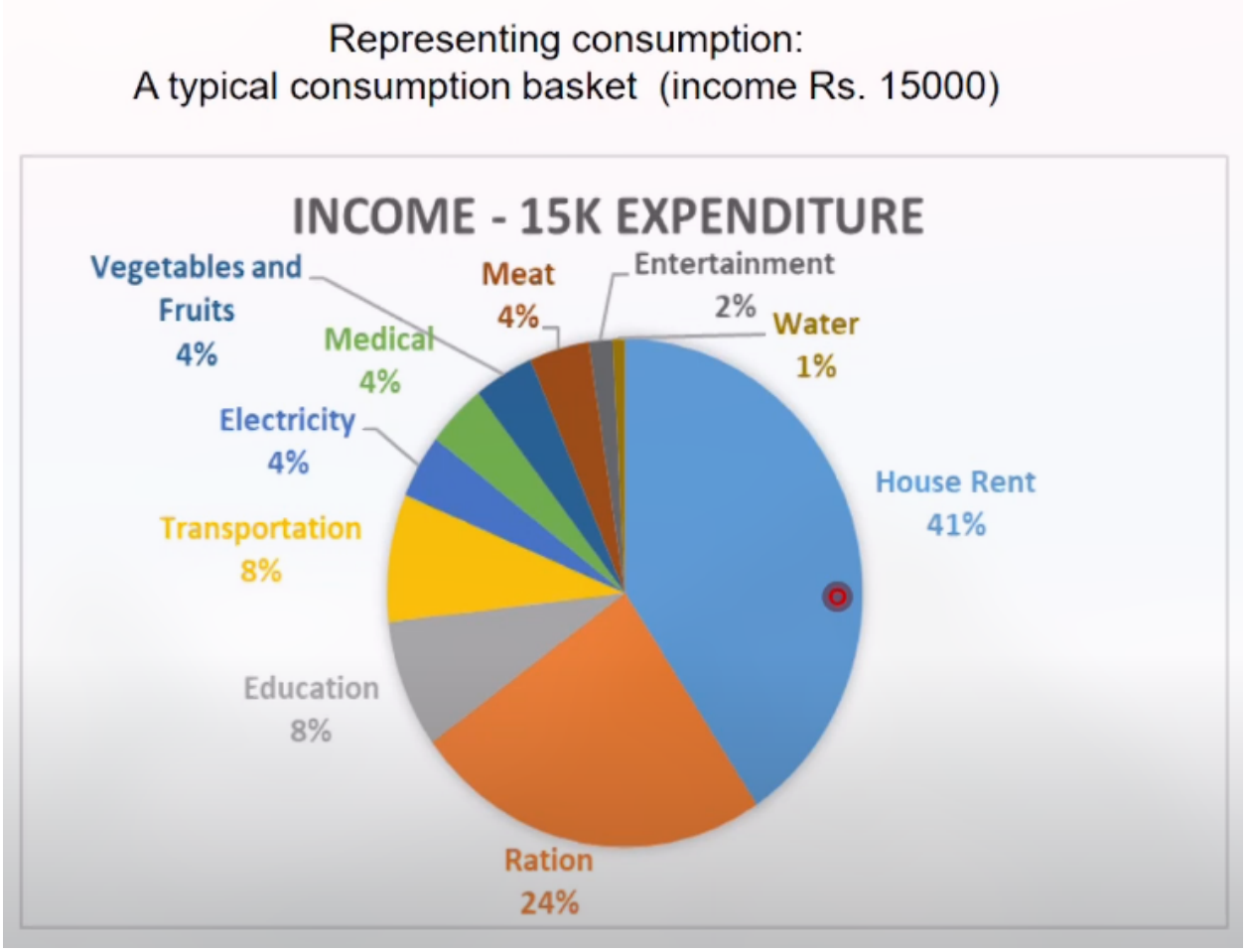


- the exchange determines the flow of things in economy and demand and supply.

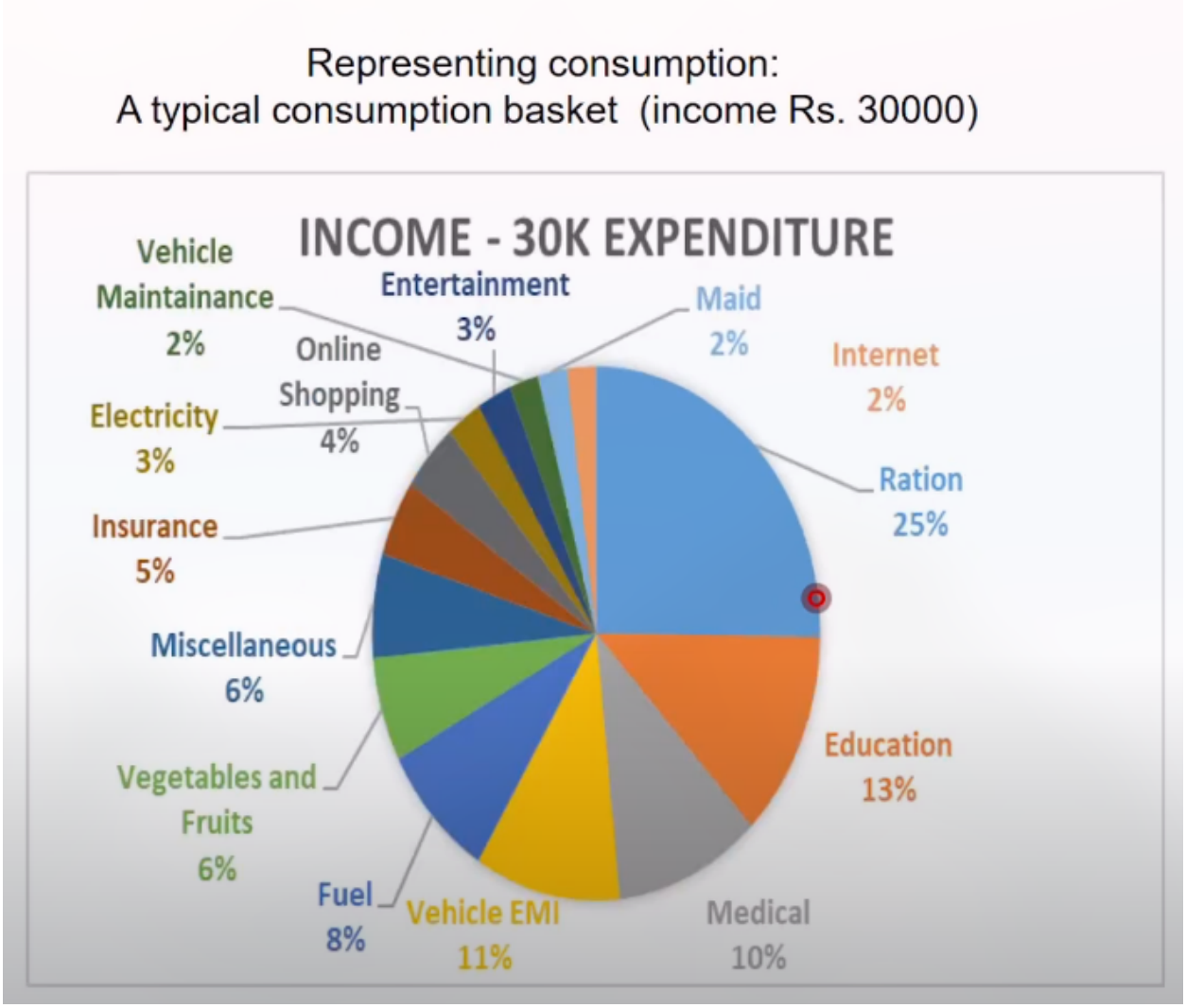
Consumption Basket

- the number of items to be consumed is very big
- the exact product may be different but be the same essense
- for such case, we look at consumption baskets and is more useful information
- categorization of items into categories is called baskets
- a basket of a household of 15k income

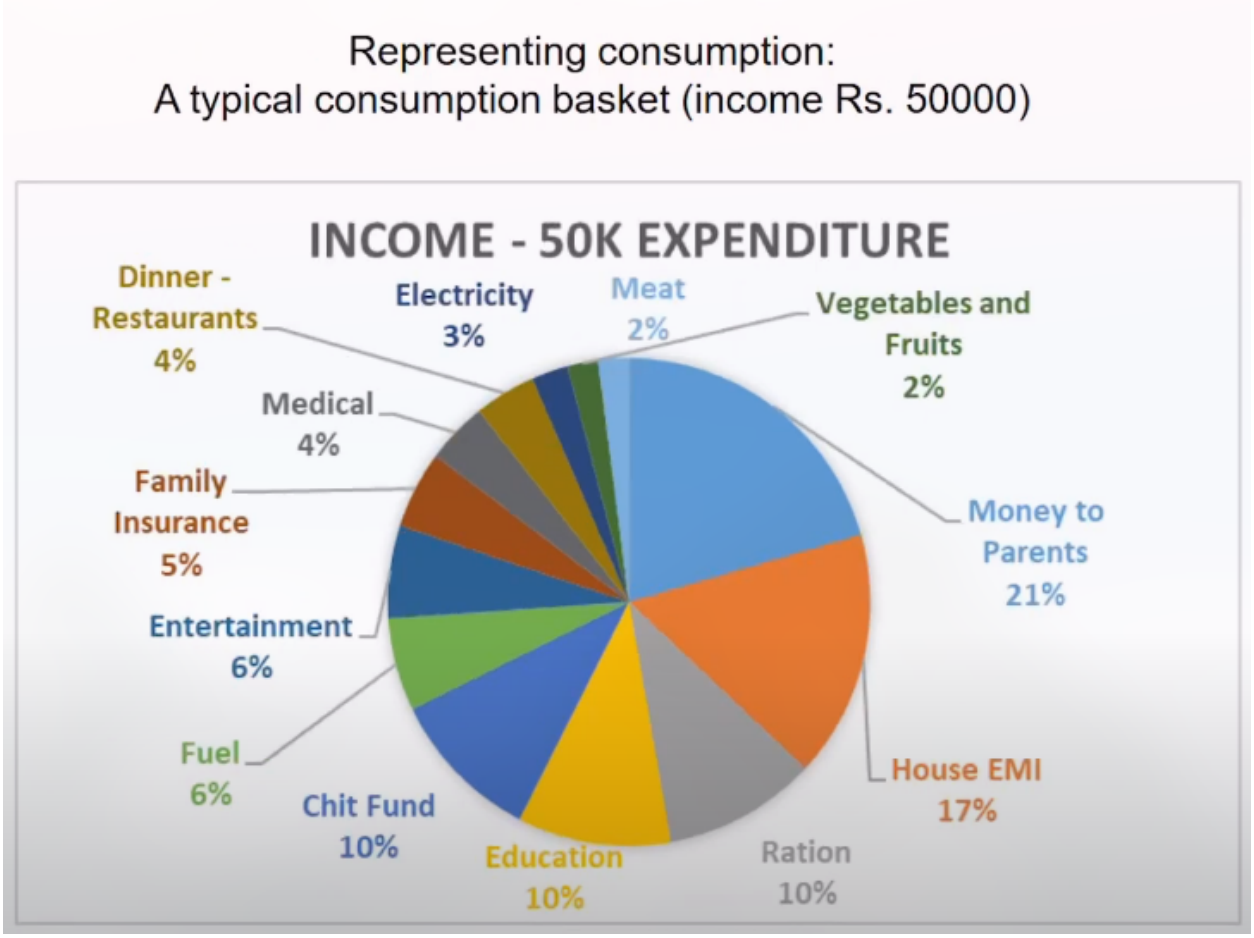
Representing consumption:
A typical consumption basket (income Rs. 15000)



- a basket of a household of 30k income



- a basket of a household of 50k income



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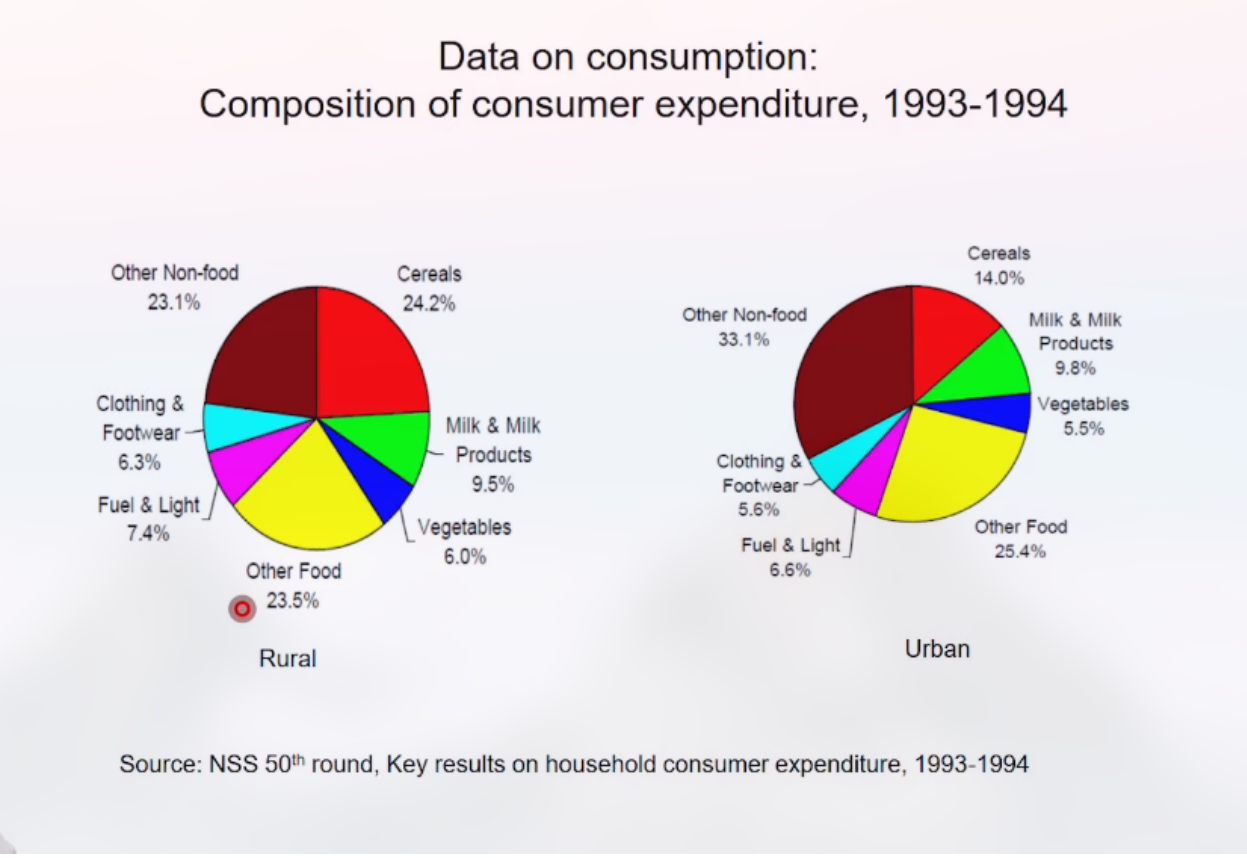
Survey Data

- Survey Data agregates macro data of economics
- surveys are typically of samples (as covering entire population is impossible)
- samples are of multiple strata of people



- with increase in choice of consumers, an increase in income creates noise in survey data, as people have wildly differing choices of discretionary spends
- to counter this high-frequency consumption data is taken, to filter out noise

biases in surveys

- bias of time: if survey is conducted near holidays, the spends will be more, etc. seasonal changes too. survey should be spread out throughout year.
- **recall bias:** people may not be able to recall everything, and they approximate such figures. If book-keeping not done correctly, these biases can creep into the survey data. to minimize the recall bias NSS uses three inputs: consumption in a day, a week, and a month
- time series data of surveys

Table T9: Trends in percentage composition of consumer expenditure since 1993-94

item group	rural					urban				
	share in total consumer expenditure in									
	1993-94	1999-2000	2004-05	2009-10	2011-12	1993-94	1999-2000	2004-05	2009-10	2011-12
(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
cereals	24.2	22.2	18.0	15.6	12.0	14.0	12.4	10.1	9.1	7.3
gram	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
cereal substitutes	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
pulses & products	3.8	3.8	3.1	3.7	3.1	3.0	2.8	2.1	2.7	2.1
milk & products	9.5	8.8	8.5	8.6	9.1	9.8	8.7	7.9	7.8	7.8
edible oil	4.4	3.7	4.6	3.7	3.8	4.4	3.1	3.5	2.6	2.7
egg, fish & meat	3.3	3.3	3.3	3.5	3.6	3.4	3.1	2.7	2.7	2.8
vegetables	6.0	6.2	6.1	6.2	4.8	5.5	5.1	4.5	4.3	3.4
fruits & nuts	1.7	1.7	1.9	1.6	1.9	2.7	2.4	2.2	2.1	2.3
sugar	3.1	2.4	2.4	2.4	1.8	2.4	1.6	1.5	1.5	1.2
salt & spices	2.7	3.0	2.5	2.4	2.4	2.0	2.2	1.7	1.5	1.7
beverages, etc.	4.2	4.2	4.5	5.6	5.8	7.2	6.4	6.2	6.3	7.1
food total	**63.2**	**59.4**	**55.0**	**53.6**	**48.6**	**54.7**	**48.1**	**42.5**	**40.7**	**38.5**
pan, tobacco, intox.	3.2	2.9	2.7	2.2	2.4	2.3	1.9	1.6	1.2	1.4
fuel & light	7.4	7.5	10.2	9.5	9.2	6.6	7.8	9.9	8.0	7.6
clothing & bedding	5.4	6.9	4.5	4.9	6.3	4.7	6.1	4.0	4.7	5.3
footwear	0.9	1.1	0.8	1.0	1.3	0.9	1.2	0.7	0.9	1.2
misc. g. & services	17.3	19.6	23.4	24.0	26.1	27.5	31.3	37.2	37.8	39.7
durable goods	2.7	2.6	3.4	4.8	6.1	3.3	3.6	4.1	6.7	6.3
non-food total	**36.8**	**40.6**	**45.0**	**46.4**	**51.4**	**45.3**	**51.9**	**57.5**	**59.3**	**61.5**
total expenditure	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

URP estimates shown except for 1999-2000, for which only MRP estimates are available.

Source: NSS 68th round, Key indicators of household consumer expenditure in India, 2011-2012

- things to note: percentage spent on food has reduced. this can mean they are eating less, or food is cheaper, or income has increased but food intake has not. Its most probably the last two.
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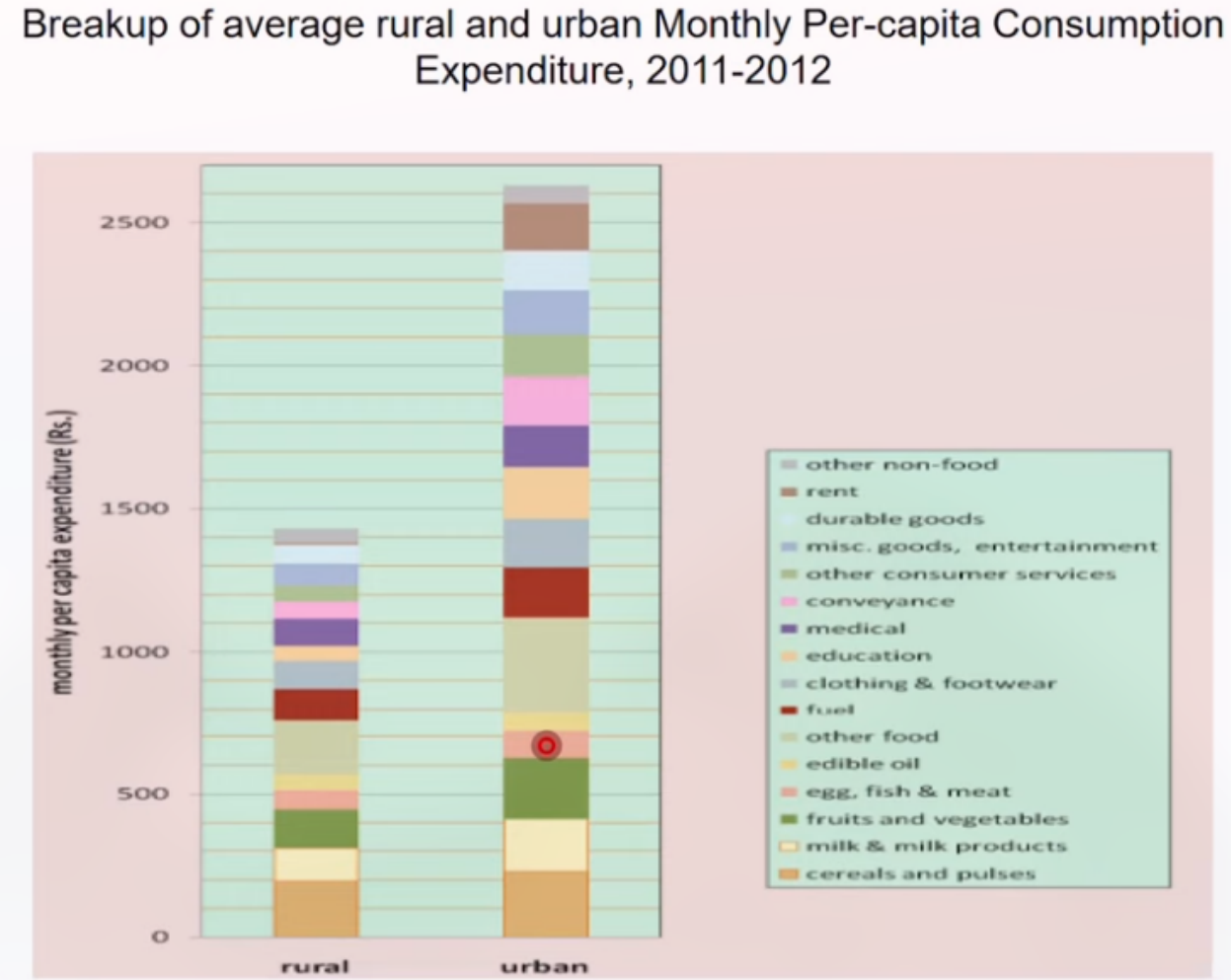
white goods

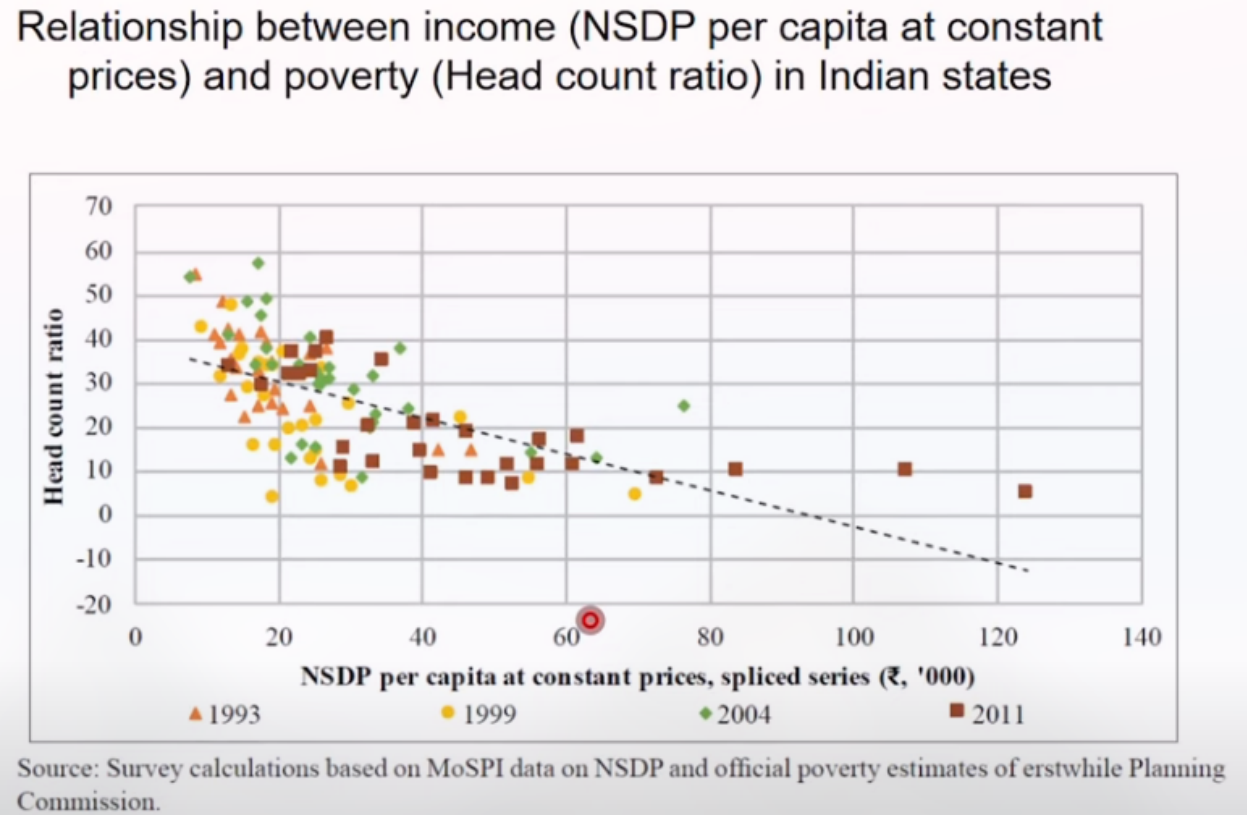
noun

large electrical goods used domestically such as refrigerators and washing machines, typically white in colour.

- average spends of rural vs urban in absolute quantities



- net state domestic product vs poverty herad count ratio



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Utility

- utility is what drives consumers' choice
- it is the combination of goods and services one consumes
- it also depends on the total income (how much they can afford)
- observe the relation between income and **total utility** or satisfaction derived from those choices
- utility is the term economists use to describe the satisfaction or happiness a person gets from consuming a good or service.

prices

- the prices of products directly affect the utility of the product

- every good has value
- as everything is finite in amount, every thing has a value attached to it, if it were infinite it would be free.
- price usually serves as the rationing device whereby their use is kept down to the available supply.
- price is a tool of rationing the supply of the goods

Sources of Survey Data

- large scale surveys take a lot of time and become obsolete fast
- we need fast realtime data sources

Consumer Pyramid Household Survey

- conducted by private firm, in waves
- it is a continuous survey to measure household well-being in india
- it is conducted thrice a year
- surveyed over 200k + households
- **panel data:** same household is getting surveyed again and again
- units of data is paid and private, but highlights of data are public

types of data:

- time series data - data over time, example GDP
- cross sectional data - data taken at one instance of time - example NSS data
- pooled time series and cross-sectional - **longitudinal data**: pooling of observations over time
    - **panel data:** pooling of observations but over same households or firms

This helps us understand the mobility of households

mobility

> Economic mobility is the ability of an individual, family or some other group to improve their economic status—usually measured in income. Economic mobility is often measured by movement between income quintiles.

Surveys like these help firms forecast the market, as high frequency data (HFI - high frequency indicators) are required to accurately and in time analyze the current market sentiment, which helps predicting near future behaviours as well.

For most firms its not economically viable to perform individual surveys, so its better to rely on these large scale surveys and HFIs. These surveys also have more geographic reach than a small or midsize firm can achieve.

Firms can also utilize these large scale surveys to find out different strata of the market, and where on the pyramid they want to locate their customers.

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notes

Financial Statement

Financial statement of a company: Financial statements are **a set of documents that show your company's financial status at a specific point in time**. They include key

data on what your company owns and owes and how much money it has made and spent. They include

- **Balance sheet -**

  The balance sheet is a company's financial report that records information related to assets, liabilities that must be paid to other parties, and capital owned by business owners in a certain period.

  With this balance sheet, it will make it easier for business owners to identify the assets, liabilities, and capital needed in the coming period.

  - **Assets**

    Assets are assets owned by business entities that are used to support business activities and can be converted into cash. These assets can be physical or non-physical assets originating from transactional activities or past activities.

    Examples of assets in a business are cash/money, land, machine tools, inventory equipment, and property.

    Meanwhile, non-physical assets can be in the form of royalties, patents, and intellectual property.

    Generally, a company has 4 types of assets, namely:

    - Current assets
    - Fixed Assets
    - Long-term investment (Long term investment)
    - Intangible Fixed Assets

    Usually, the Assets post is in the left position on the Balance Sheet.

  • **Liabilities**

    Liabilities are debts owned by a business entity and are obligated to be paid to the party giving the debt. Examples of these liability items are short-term and long-term loans, taxes, bonds, and others. Usually the liability item is on the right side of the balance sheet.

  - **Equity**

Equity is the capital included by the owner of a company. In other words, equity is the ownership rights to the company's assets after deducting the liabilities. This amount of equity will decrease if the owner of the company withdraws a certain number of assets. Usually, the location of this equity item is on the right side of the Balance Sheet together with the liabilities item.

- **Income Statement (P/L Statements) -**

  The second type of financial report is the income statement. As the name implies, the income statement contains information about whether a company experienced a loss or profit in a certain period. Income statements are usually made at the end of the year or the end of the month. This type of financial report is very important for management because it is used as material for evaluating financial performance for 1 year. What are the points that can lead to gains or losses, whether there are costs that are too large to be charged or the income earned is in line with the target or not.

  There are 4 elements contained in the income statement, namely:

  - Revenue
  - Expenses
  - Profit
  - Loss

  To determine the profit earned, it is also divided into 5 types, namely:

  1. Gross Profit
  2. Operating Profit
  3. Profit Before Tax
  4. Net Income
  5. Current Operating Profit

- **Cash Flow Statements -**

  The third type of financial report is the statement of cash flows. A statement of cash flows or commonly called cash flow is a type of financial report that contains information about expenditures and cash inflows made by a business

entity during a certain period. This information contains details regarding the amount of cash received, debt expenses and payments, and so on.

The function of the cash flow statement is as a means of evaluating the company's ability for future business activities. From the cash flow statement, it can be seen whether the company can pay its obligations/debt or not.

There are 3 important elements that must be included in the statement of cash flows, namely:

1. Operational Activities

Cash flows from operating activities can come from the sale of goods or services from customers, purchases of company equipment and tools that have an asset life of less than 1 year, and other operating expenses. In other words, cash flows from operating activities contain the company's main revenue-generating activities.

2. Investing Activities

Meanwhile, cash flows from investing activities are cash flows that include transactions for purchasing assets that have a lifespan of more than 1 year or long-term benefits. For example, buying stocks and bonds, purchasing property, and other equipment.

3. Financing Activities

The last component of the statement of cash flows is the component that comes from financing activities. This funding activity can come from activities that can increase or decrease the company's capital. Therefore, the financing activity post is closely related to dividend payments, repayment of long-term credit/debt, and the like.

- **Statements of change in capital -**

A report on changes in capital or equity is a type of financial report that contains information about changes in equity at a certain time. Through this report, readers can see various changes related to incoming and used capital. This report is generally prepared after the income statement and balance sheet.

The capital change report consists of several important parts:

- Initial capital

Contains information on the amount of existing capital at a certain time period.

- Additional Capital

  Contains information regarding the addition of business or company capital over a certain period of time. For example, additional capital in the form of dividend payments retained earnings and additional paid-in capital.

- Decrease in Capital

  Presents information regarding a decrease in existing capital at a certain time. For example, the decrease in the capital in the second quarter is due to last year's dividend payments that have not been paid.

- Final Capital

  Displays the amount of the final capital for a certain time.

The existence of a report on changes in the capital is very useful for business owners, stakeholders, investors, and parties who have authority over the company to find out changes in equity, evaluate, and plan the company's finances in the future.

- **Notes to Financial Statements -**

  The fifth type of financial report is the Notes to Financial Statements. This report contains additional information from the four reports above to help readers understand the existing financial reports.

  The record usually consists of several sub-sections which include:

  - General information

    Generally contains information about a business or company. For example, company name, address, and purpose of establishment.

  - Accounting Principles Used

    The principles used to prepare financial statements, such as fair value accounting principles and historical cost accounting principles.

  - Existing Assumptions

Assumptions used to prepare the report. This assumption is closely related to economic terms. For example, the assumption of economic life and reasonable interest rates.

- Method Used

  Presents information about the methods used during the process of preparing financial statements. For example the depreciation method, recognition method, and expense recognition method.

- Other Information Considered Important

  As the name implies, this sub-section contains other important information, such as information on transactions with certain parties, long-term contracts, and financial risks.

In short, Notes to Financial Statements are very useful to make it easier for readers to understand the financial statements presented.

Marginal Utility

Marginal utility is the added satisfaction that a consumer gets from having one more unit of a good or service. The concept of marginal utility is used by economists to determine how much of an item consumers are willing to purchase.

Positive marginal utility occurs when the consumption of an additional item increases the total utility. On the other hand, negative marginal utility occurs when the consumption of one more unit decreases the overall utility.

KEY TAKEAWAYS

- Marginal utility is the added satisfaction a consumer gets from having one more unit of a good or service.
- The concept of marginal utility is used by economists to determine how much of an item consumers are willing to purchase.
- The law of diminishing marginal utility is often used to justify progressive taxes.
- Marginal utility can be positive, zero, or negative.

Types of Marginal Utility:

- Positive - when consuming more makes you more satisfied
- Zero - when consuming more makes no change to your satisfaction
- Negative - when consuming more reduces your satisfaction, usually when already consumed too much

Law of Diminishing Marginal Utility

As number of units consumed increase, marginal utility decreases, but depending on the good, it may or may not reach zero and/or negative.

> 💡 **Water vs Diamond Utility ❗**
> It shows that value is based off of final marginal utility instead of total utility.

Consumption ends when marginal utility becomes zero.

Total Utility

It is the total amount of utility you gain by consuming all the units of goods you purchase. Marginal Utility affects Total Utility, if MU for the next unit is positive, TU will increase. If it is zero, TU remains same. If MU is negative, TU decreases.

$$\text{Marginal Utility} = \Delta TU / \Delta Q$$

Applications of MU

Consumers

Consumers seek out products with higher marginal utility. Because their satisfaction stays high with each additional unit purchased, they are more likely to purchase more. They are also more likely to buy similar products from the same company, expecting them to have a similarly high level of marginal utility.

Higher marginal utility often leads to greater customer satisfaction because consumers feel they are getting their money's worth. This can lead to brand loyalty over time, as well as word-of-mouth recommendations.

Businesses

Products that offer a higher level of satisfaction over time, and after the first time they are used, offer a higher level of marginal utility. This makes them more valuable to customers, so they can be priced higher for greater profits. This can also serve as a guide for businesses to create better products and increase customer satisfaction by focusing on products that offer higher marginal utility.

Marginal utility can also guide businesses when deciding which products to innovate or upgrade. A product or service that already has a high level of marginal utility becomes even more valuable when it is improved, allowing businesses to continue increasing the price over time or for newer models. For example, if a car manufacturer has an SUV that is already a top seller, they can create trim levels with additional features or upgrades. Because the original version is already popular, with a high marginal utility, customers are more likely to pay the increased price for an even more premium version.

Governments

The law of diminishing marginal utility is often used to justify progressive taxes. The idea is that higher taxes cause less loss of utility for someone with a higher income. In this case, everyone gets diminishing marginal utility from money. Suppose that the government must raise $10,000 from each person to pay for its expenses. If the average income is $60,000 before taxes, then the average person would make $50,000 after taxes and have a reasonable standard of living.

However, asking people making only $10,000 to give it all up to the government would be unfair and demand a far greater sacrifice. That is why poll taxes, which require everyone to pay an equal amount, tend to be unpopular.

Also, a flat tax without individual exemptions that required everyone to pay the same percentage would impact those with less income more because of marginal utility. Someone making $15,000 per year would be taxed into poverty by a 33% tax, while someone making $60,000 would still have about $40,000.

Marginal Cost

In economics, the marginal cost is the change in total production cost that comes from making or producing one additional unit. To calculate marginal cost, divide the change in production costs by the change in quantity. The purpose of analyzing marginal cost is to determine at what point an organization can achieve economies of scale to optimize production and overall operations. If the marginal cost of producing one additional unit is lower than the per-unit price, the producer has the potential to gain a profit.

Consumer Behaviour and Markets

Tags	cardinal curve indifference ordinal utility
Course	BDM
# Week	2
Created time	@June 16, 2023 7:05 PM

Consumer Behaviour and Markets

Utility: Cardinal vs Ordinal

- Market: a generic typical market

Theory of Consumer Behaviour:

- consumer has limited resources (income)
- he attempts to allocate his limited resource among available goods and services
- so as to **maximize his utility (satisfaction)**
- **Utility:** amount of satisfaction derived from the consumption of a commodity, measurement units → utils
- Consumption is a function of income and utility
- The unit of utility is **hypothetical**.

Utility Concepts:

- The Cardinal Utility Theory (**TUC):**
  - utility is measurable in cardinal sense

    - cardinal utility assumes that we can assign values for utility, eg derive 100 utils from eating a slice of bread.
- The Ordinal Utility Theory (**TUO):**
    - utility is measurable in ordinal sense
    - ordinal utility approach does not assign values, it instead works with a ranking of preferences

The Cardinal Utility Approach

- It says that utility is a numeric value measures in numeric sense, hence difference of two utilities is itself numerically significant
- $U_x = f(X)$
- $U_y = f(Y)$
- Utility is maximized when:

$$\frac{MU_x}{MU_y} = \frac{P_x}{P_y}$$

It says that we look at marginal utility of consumption, rather than the utility itself. It says that the resource allocation depends on ratio of marginal utility and ratio of price.

- **Total Utility:** the overall level of satisfaction derived from consuming a good or service
- **Marginal Utility**: additional satisfaction that an individual derives from consuming an additional unit of a good or service

$$\begin{aligned} MU &= \frac{\text{Change in total utility}}{\text{Change in quantity}} \\ &= \frac{\Delta TU}{\Delta Q} \end{aligned}$$

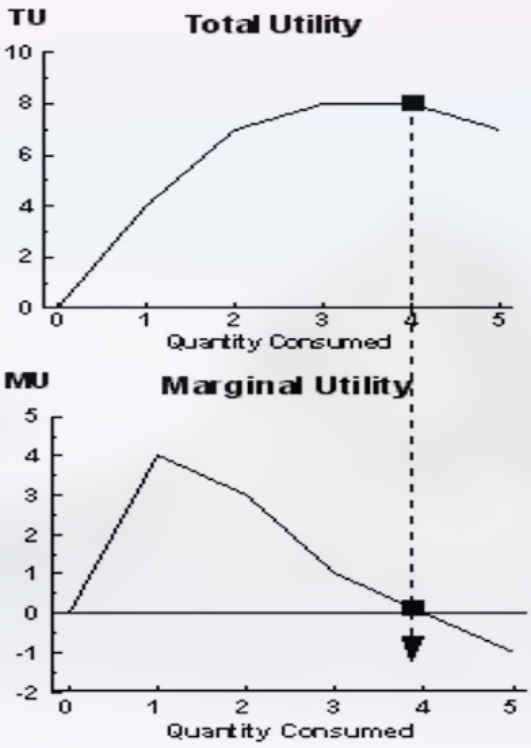
We are assuming that each additional unit will give some utility (positive or negative or zero, that is it is not undefined).

💡 **Law of Diminishing Marginal Utility (Return) -** As more and more of a good is consumed, the process of consumption will at some point yield smaller and smaller additions to utility. (TU is non-monotonically decreasing function)

- When total utility is maximum, marginal utility is zero.
- when the total utility begins to decrease, the marginal utility is negative.

EXAMPLE

Number Purchased	Total Utility	Marginal Utility
0	0	0
1	4	4
2	7	3
3	8	1
4	8	0
5	7	-1



Therefore a person will keep on consuming to maximise their utility,

- they have a fixed income (I)
- each good has a fixed price (P_x, P_y)
- each good has a marginal utility (M_x, M_y)

A consumer stops consumption when

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y}$$

Thus if LHS > RHS then consumer consumes more of X to make the equality. This basically means that we will always choose that option that gives the most MU per price. (and consuming that will alter its MU, so choice will not be same after consumption).

The Ordinal Approach (TUO)

Says that utility is only measurable in ordinal value, that is, it can only be ranked.

There is no unit.

- The preferences can be ranked
- The ranking can be plotted into **indifference curve**
- People will try to maximize their utility given their available resources

Indifference Curves

- Represent a combination of items when consumer at indifference situation (satisfaction)

Axes: both axes refer to quantity of goods.

- For the combination that produces higher level of satisfaction the curve shifts to the right from the original curve

Properties of Indifference Curves

- Downward sloping from left to right - this shows an increase in quantity of certain good.
- Convex to the origin - The marginal rate of substitution is decreased.

    - MRS = quantity of good Y willing to substitute to obtain one unit of good X to maintain same level of satisfaction.
- Do not cross (intersect) - consumer preference is transitive
- Different IC show different level of satisfaction.

💡 **Key Difference between Cardinal Utility and Ordinal Utility:**

- Cardinal Utility is a utility that determines the satisfaction of a commodity used by an individual and can be supported with a numeric value. On the other hand, Ordinal Utility defines that satisfaction of user goods can be ranked in order of preference but cannot be evaluated numerically.
- The measuring term for cardinal and Ordinal Utility is utils and ranks respectively. Utils is the unit of utility and ranks determine the preference of a product compared to other products in the market.
- Ordinal Utility measures the utility of goods subjectively, but Cardinal Utility evaluates objectively.
- Cardinal Utility is not much realistic as compared to the Ordinal Utility as quantitative evaluation of utility is not practicable. Ordinal Utility depends on qualitative measurement, which makes it more realistic.
- Another difference between ordinal and Cardinal Utility is that the former one is based on indifference curve analysis, and the latter is based on marginal utility evaluation.
- Alfred Marshall and his admirers presented the Cardinal Utility approach, and Hicks and Allen pioneered the Ordinal Utility idea.

Demand and Supply

Market

A group of buyers and sellers

Buyers → determine demand of the product

Sellers → determine the supply of the product

Demand

Quantity Demand

The amount of a good that buyers are willing and able to purchase

Law of demand

Other things being equal, when the price of the good rises, quantity demanded of good falls

Demand schedule - a table

Relation between the price of agood and quantity demanded.

Demand curve - a graph

Graph between the price of a good and quantity demanded.

It can be individual level, or aggregate.

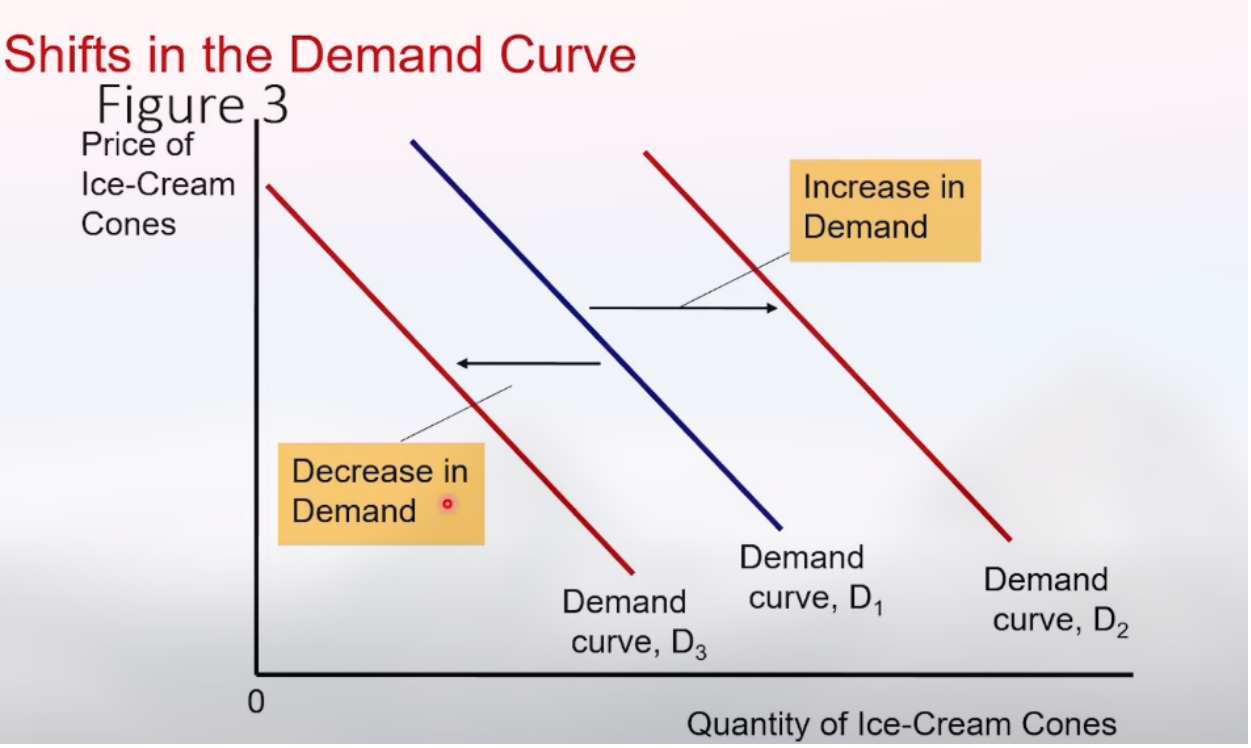
Demand curve always slopes downward, curve may not be linear.

Market Demand Curve

Sum of individual demand curves horizontally

Shifts in demand curve

- Increase in demand
  - any change that increases the quantity demanded at every price
  - demand curve shifts to the right
- Decrease in demand
  - Any change that decreases the quantity demanded at every price
  - demand curve shifts left



Variables that affect demand curve

- income
- prices of related goods
- tastes
- expectations

- number of buyers

Income

- normal good
  - increase in income leads to increase in demand
- inferior good
  - increase in income leads to decrease in demand

Prices of related goods

- substitutes - two goods
  - an increase in the price of one leads to increase in demand of other
- complements - two goods
  - increase in price of one leads to decrease in the price of other

Tastes

- change in taste changes demand

Expectation about future

- expect an increase in income
  - increase in current demand
- expect higher prices
  - increase in current demand

number of buyers

- if number increases
  - market demand increases

Variable	A Change in This Variable . . .
Price of the good itself	Represents a movement along the demand curve
Income	Shifts the demand curve
Prices of related goods	Shifts the demand curve
Tastes	Shifts the demand curve
Expectations	Shifts the demand curve
Number of buyers	Shifts the demand curve

Supply and Demand Together

- equilibrium - a situation
  - supply and demand forces are in balance
- a situation in which market price has reached the level where
  - quantity supply = quantity demand
- equilibrium price
  - balances quantity supplied and quantity demanded
  - market clearing price
- equilibrium quantity
  - quantity supplied and quantity deamnded at the equilibrium price

Surplus

- Quantity supplied > quantity demanded
- excess supply (surplus)
- downward pressure on price (price has to decrease)
    - movement along the demand and supply curves
    - increase in quantity demanded
    - decrease in quantity supplied

Shortage

- Quantity demanded > quantity supplied
- excess demand (shortage, price will increase)
- upward pressure on price
    - movement along the demand and supply curves
    - decrease in quantity demanded
    - increase in quantity supplied]

So market self-corrects.

Law of supply and demand

- The price of any good adjusts
    - to bring the quantity supplied and the quantity demanded for that good into balance
- in most markets surpluses and shortages are temporary
- prices
    - signals that guide the allocation of resources
    - mechanism for rationing scarce resources
    - determine who produces each good and how much is produced

Changes in Demand and Elasticity

Elasticity

Measure of responsiveness for quantity demanded or quantity supplied to a change in one of its determinants

Price elasticity of demand

- how much the quantity demanded of a good responds to a change in the price of that good

$$E_d^p = \left| \frac{\frac{\Delta \text{Quantity}}{\text{Quantity}}}{\frac{\Delta \text{Price}}{\text{Price}}} \right|$$
$$= \frac{\Delta \text{Quantity}}{\Delta \text{Price}} \times \frac{\text{Price}}{\text{Quantity}}$$

Elastic Demand

Quantity demanded responds substantially, PEd is high

Inelastic Demand

Quantity demanded responds only slightly to changes in price, PEd is low

Determinants of price elasticity of demand

- close substitutes
  - goods with close substitutes are more elastic demand
- necessites vs luxuries
  - necessities - inelastic demand

- luxuries - elastic demand

If PEd > 1, demand is elastic

If PEd < 1, demand is inelastic

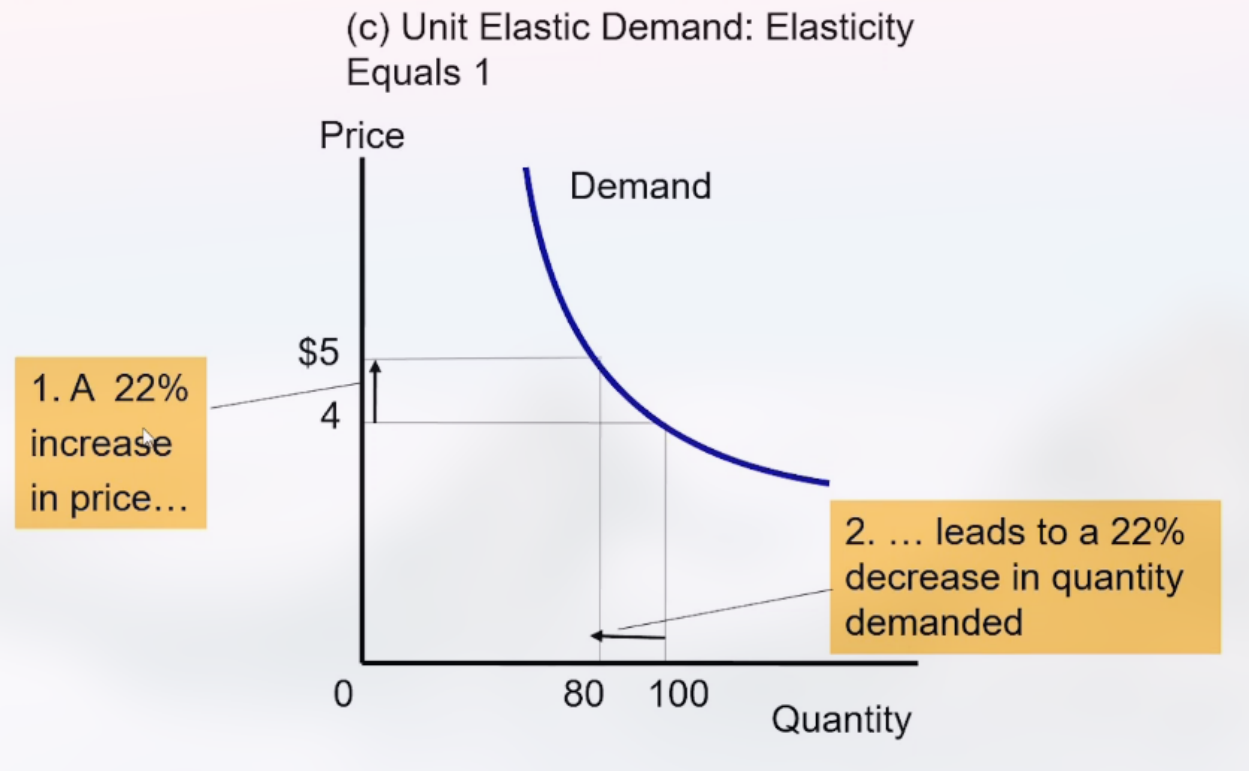
If PEd = 1, demand has unit elasticity

If PEd = 0, perfectly inelastic, demand curve is vertical

If PEd = infinity, perfectly elastic, demand curve is horizontal

The flatter the demand curve, the greater the price elasticity of demand

elasticity is not just the slope, but also the position on the cuve.



Income Elasticity of demand

- how much the quantity demanded of a good responds to a change in consumer's income
- percentage change in quantity divided by percentage change in income

- normal goods
  - positive income elasticity
  - necessities
    - smaller income elasticities
  - luxuries
    - large income elasticities
- inferior goods

    - negative income elasticities

Cross-Price Elasticity of Demand

- How much the quantity demanded of one good reponds to a change in the price of some OTHER good
- percentage change in quantity demanded of the first good divided by change in price of second good

Substitutes

- goods typically used in place of one another
- positive cross-price elasticity of demand

Complements

- Goods that are typically used together
- negative cross-price elasticity

Price Elasticity of Supply

- How much the quantity supplied of a good responds to a change in the price of that good
- percentage change in quantity supplied divided by percentage change in price
- depends on the flexibility of sellers to change the amount of the good they produce

Elastic and Inelastic Supply

- Elastic Supply - quanity supplied responds substantially to changes in price

- Inelastic Supply - Quantity supplied responds slightly to changes in price

Determinants of price elasticity of supply

- time period
    - supply is more elastic in long run

Income and Substitution Effects of a price change

- income effect - a change in a consumer’s real purchasing power brought about by a change in the price of a good
- substitution effect - an incentive to increase consumption of agood whose price falls, at the esxpense of other, now relatviely more expensive goods

Price and Income Elasticities of Demand

- Income Elasticity measures shift in the demand-curve
- Price elasticity measures movement along the curve
- Cross-price elasticity measures shift in the demand curve (substitures and complements)

Normal and Inferior Goods

- normal goods have positive income elasticity
- inferior goods have negative income elasticity

Necessities and Luxuries

- Necessities - income elasticity between 0 and 1

- Luxuries - income elasticity above 1

Production Cost

Objective of firm is to maximize profits. There are supply curve and determinants of supply curve. Most important determinant being **cost of production.**

Firm has a capital available. They need to distribute the capital into cost of production of goods, maximizing the profit.

Cost of Production depends on

- Cost varies from industry to industry
- The size of the firm
- Technology available for production

Types of Production Cost

- Opportunity Cost and Actual Cost
- Direct and Indirect cost
- Explicit and Implicit Cost
- Historical and Replacement Cost
- Fixed and Variable Cost
- Real and Prime Cost
- Total Cost, Average Cost, and Marginal Cost

Opportunity Cost

Cost of losing the next best alternative

Actual Cost

Actual amount paid as opposed to the estimated or standard cost.

Implicit Cost

Amount spend in using the organization’s own resources for the process of production

Explicit Cost

Amount spent to purchase or hire resources outside the organization for the process of production

Direct Cost

Cost that is directly accountable to cost object or production, Example Wages paid, salary paid, material cost, etc

Indirect Cost

Cost that is not directly accountable to cost object or production, example insurance, maintenance, telecom, etc

Historical Cost

Original/Actual Cost incurred at the time of purchasing the asset

Replacement Cost

Cost incurred for replcaing the existing asset at the current market price which may not be necessarily the market value of the asset

Fixed Cost

Cost that remains unchanged and is not affected by the output level or the revenue generated from sales such as interest, rent and salaries.

Variable Cost

Cost that varies based on the company’s production volume, It increases with the increase in production and decreases with the decrease in production.

Real Cost

Physical Quantities of various factors used in producing the commodity, it signifies the aggregate of real productive resources used in production.

Example: a table’s real cost comprises of the carpenter’s labour, cubic feet of wood required, a dozen nails, half a bottle of varnish, etc.

Prime Cost

Direct cost of the commodity in terms of the materials and labour involved in its production excluding the fixed cost, Prime cost helps in detemining the selling price to generate profits.

Cost Curves

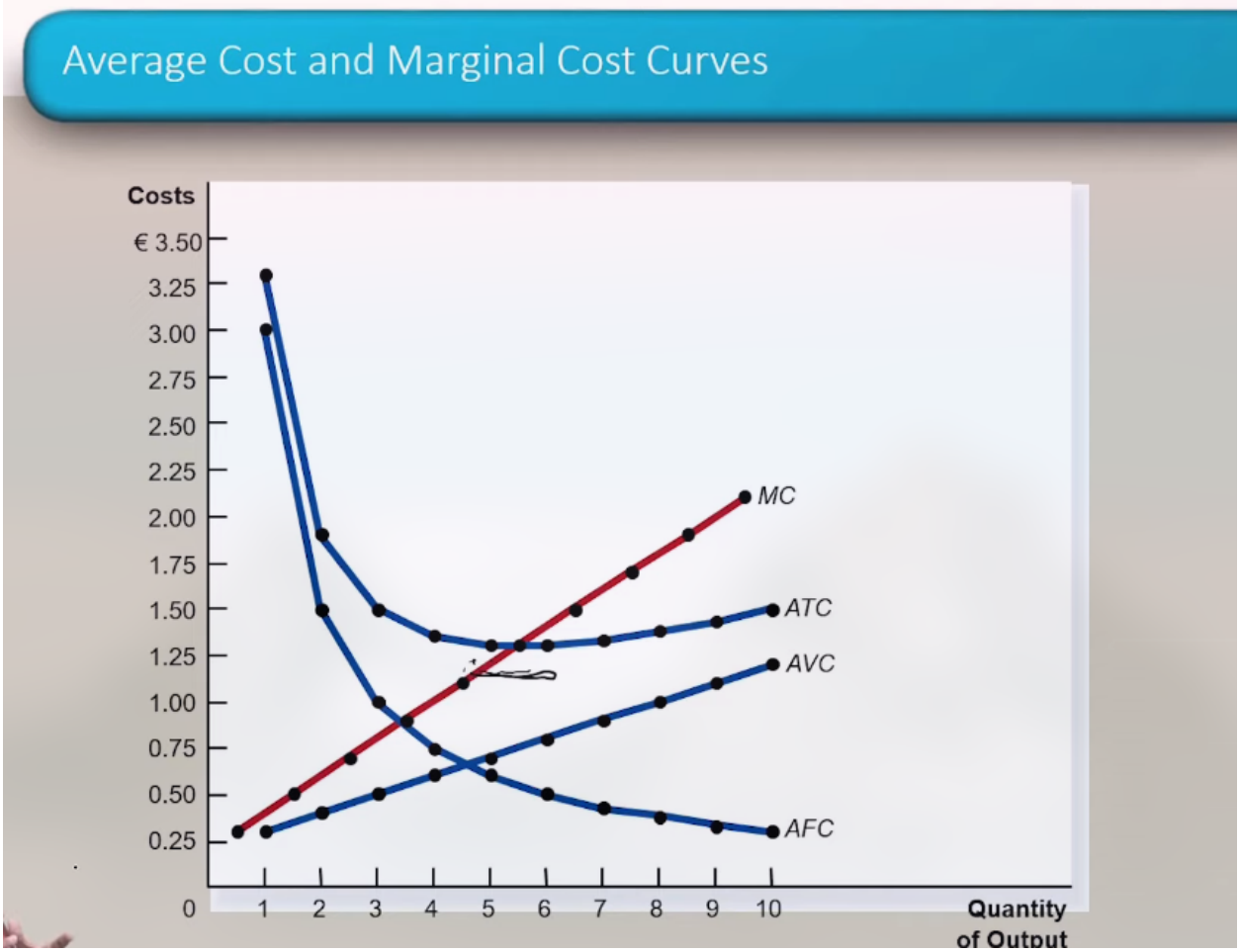
Marginal Product of Labour

Falls with increase in labour

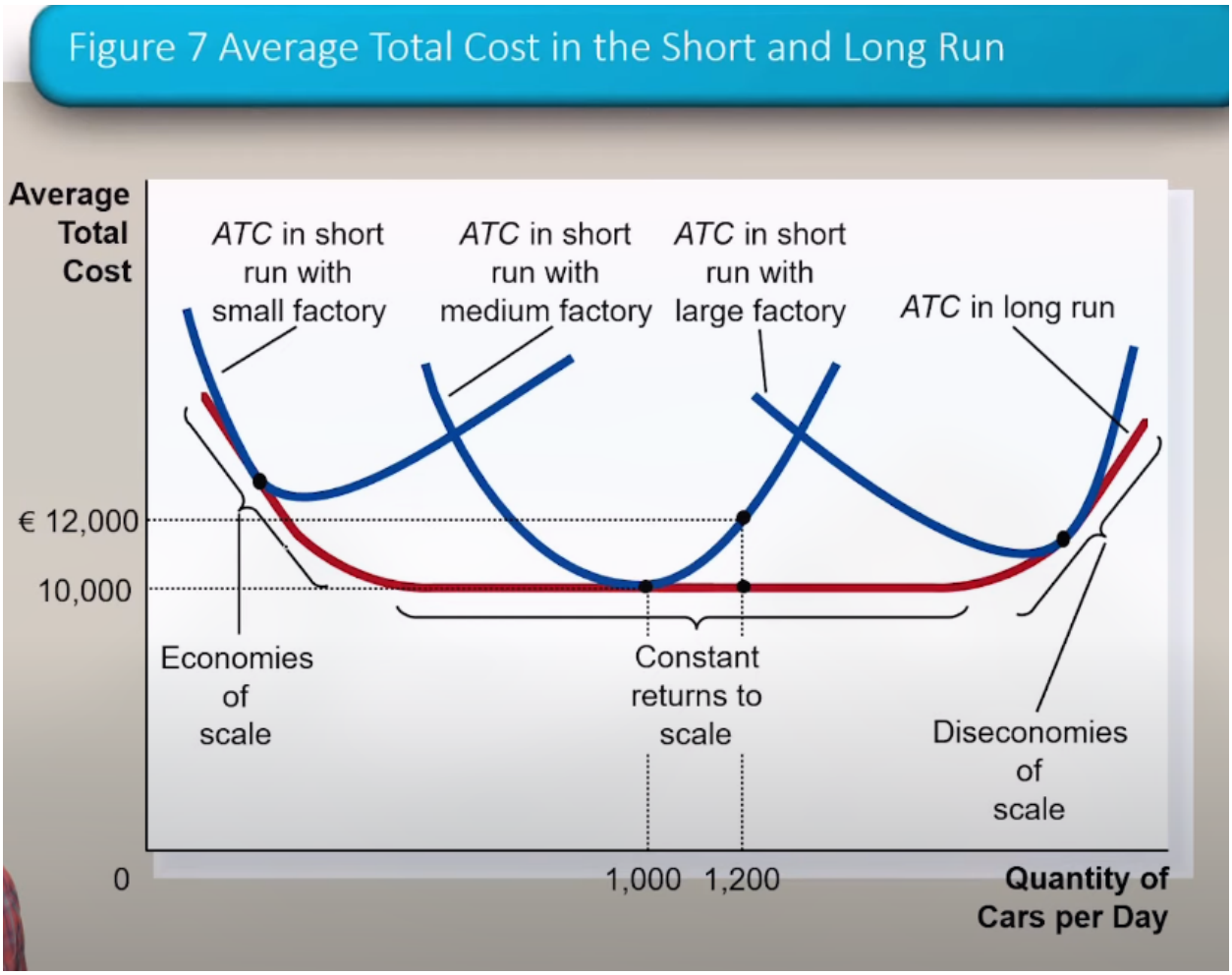
Marginal Cost

Increases with increase of production, the place where marginal cost intersects total cost is optimum amount of production.

Global minima of Average Total Cost is best amount of production. Average Total Cost is a U shaped curve, best place to be is the minima.



but in the long run there is no fixed cost, everything is variable cost. In long run the ATC is envelope of the ATC of short runs.



Key Questions of Firm

- make or buy
  - produce something by myself or buy and resell
  - outsourcing
  - fixed cost is reduced
  - function of sunkness of fixed cost
    - whether we use or not we have to pay cost
- pricing decisions
  - how much to price product

- given cost and technology, producer can decide quantity and/or price depending on the extent of market competition
- in competitive markets, only quantity can be controlled
- price competition becomes different in the presence of multiple competitiors so other instruments of competition are used.

Production Decisions

Production Function

Defines the relationship between inputs and the maximum amount that can be produced within a given period of time with a given level of technology

$$Q = f(X_1, X_2, \ldots, X_k)$$

Q = level of output

X_i = inputs used in production

Inputs in modern industries:

- capital
- labour
- energy
- materials

initialed as `KLEM`

for simplicity we consider only capital and labour here.

Short-run Production Function

The maximum quantity of output that can be produced by a set of inputs.

- Assumption - the amount of at least one of the inputs used remains unchanged.

Long-run Production Function

The maximum quantity of output that can be produced by a set of inputs.

- Assumption - the firm is free to vary the amount of all the inputs being used.

Short-run Analysis of Total, Average, and Marginal Product

- Marginal Product (MP) = change in output (Total Product) resulting from a unit change in a variable input

$$MP_x = \frac{\Delta Q}{\Delta X}$$

- Average Product (AP) = Total Product per unit of input used

$$AP_x = \frac{Q}{X}$$

Generally Marginal Product corelate with the wages of the employee.

If MP > AP, then AP is rising

if MP < AP, then AP is falling

if MP = AP, when AP is maximized

MP can be sometimes negative, in case of unions etc.

Law of Diminishing Marginal Returns

As additional units of a variable input are combined with a fixed input, after some point, the additional output (ie. the marginal product) starts to diminish

- it is not fixed when diminishing return will take effect, and its rate
- all inputs added to the production process have the same productivity

Three Stages of Production in short run

- Stage I : from zero units of the variable input to where AP is maximized (where MP = AP)
- Stage II: from the maximum AP to where MP = 0
- Stage III: from where MP = 0 on

only Stage 1 and 2 are preferable.

Long run Production Function

- In the long run, a firm has enough time to change the amount of all its inputs
- The long run production process is described by the concept of **returns to scale**
- Returns to scale = the resulting increase in total output as all inputs increase
- If all inputs into the production process are doubled, three things can happen
    - output can more than double
        - increasing returns to scale (IRTS)
    - output can exactly double
        - constant returns to scale (CRTS)
    - output can be less than double
        - decreasing returns of scale (DRTS)

Estimation of Production Functions

- Production function examples
- Cobb-Douglas function: exponential for two inputs

$$Q = aL^bK^c$$

if $b + c > 1$, then IRTS

if $b + c = 1$, then CRTS

if $b + c < 1$, then DRTS

Statistical Estimation of Production Functions

- inputs should be measured as flow rather than stock variables, which is not always possible
- usually the most important input is labor
- most difficult input variable is capital
- must choose between time series and cross-sectional analyis
- inter-firm analysis is done using cross-sectional data
- intra-firm improvement is measured using time series data.

Estimation of Production Functions

Aggregate production functions: whole industries or an economy

Gathering data for aggregate functions can be difficult.

- for an economy: GDP could be used

- for an industry: data from Annual Survey of Industries, CMIE, etc
- for labor: data from Labor Bureau, CMIE, etc

importance of production functions in managerial decision making

- careful planning can help a firm to use its resources in a rational manner
- production levels do not depend on how much a company wants to produce but on how much its customers wants to buy
- there must be careful planning regarding the amount of fixed inputs that will be used along with the variable ones

capacity planning

Planning the amount of fixed inputs that will be used along with the variable inputs

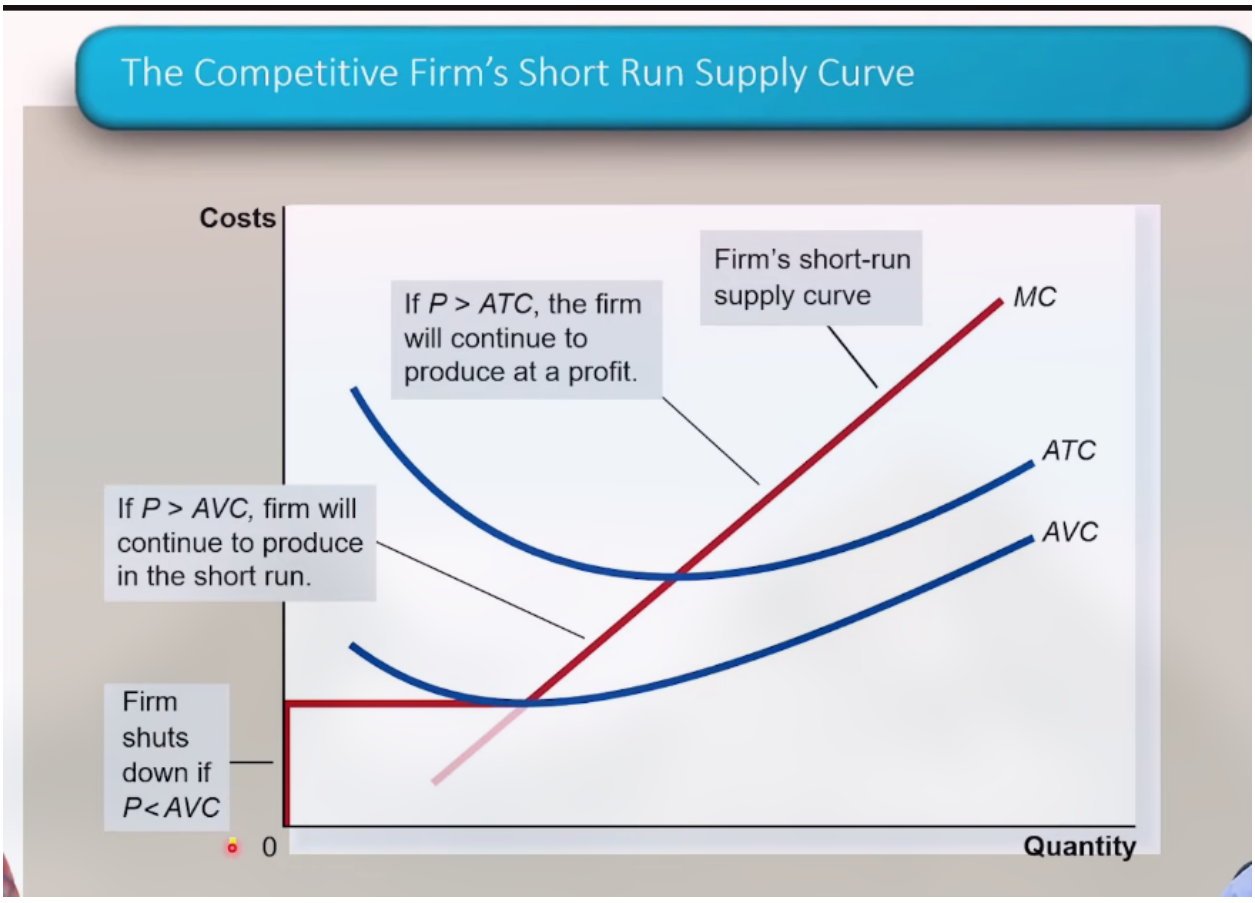
Good capacity planning requires:

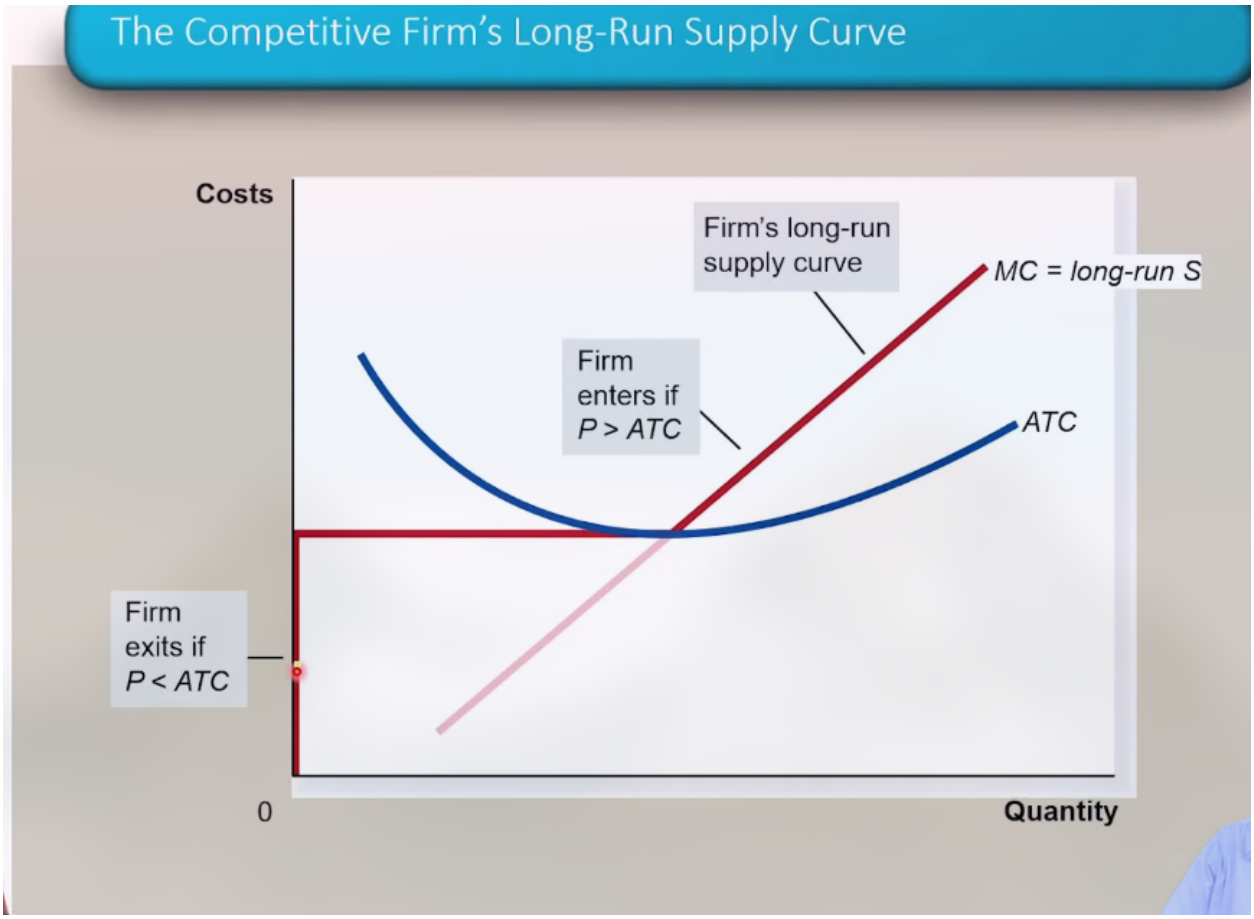
- accurate forecasts of demand
- effective communication between the production and marketing functions

Firms in Competitive Markets

- Total, Average, and Marginal Revenue
- Total Revenue → The total amount of revenue generated
- Average Revenue → Total Revenue divided by quantity sold
- Marginal Revenue is revenue generated by selling one additional unit.
- In competitive market prices are determined by market, a firm cannot change it.
- for firms in CM, average and marginal revenue always remains same.

- but marginal cost will vary.
- Change in Profit = MR - MC.
- Firm stops production when MR = MC and change in profit is zero




The Competitive Firm's Long-Run Supply Curve
Costs
Firm's long-run supply curve
MC = long-run S
Firm enters if P > ATC
ATC
Firm exits if P < ATC
0
Quantity

Pricing

Tags	FMCG IT cement key ratios pricing strategy textile
Course	BDM
# Week	3
Created time	@July 30, 2023 8:43 PM

Pricing Strategies

Pricing Strategy Objectives:

- Long Run Profits
- Short Run Profits
- Increase Sales Volume
- Company Growth
- Match Competitors Price
- Create Interest and Excitement about Product
- Discourage Competitors from cutting price
- Social, Ethical, and Ideological Objectives
- Discourage New Entrants
- Survival

Factors affecting Price

Types of Pricing Strategy

- Market Skimming Pricing:
  - High Price, Low Volume
  - Skim the profit from the market
  - Suitable for products that have short lifecycle or which will face competition at some point in future
  - example: Playstation, digital technologies, DVD
- Value Pricing:
  - based on consumer perception
  - price charged according to customer perception
  - price set by company according to perceived value
  - example: status products and exclusive products

- Loss Leader Pricing
  - Sold at loss to encourage sale elsewhere
  - Other items cover the loss
- Psychological Pricing
  - Used to play on consumer perceptions
  - example: Rs. 9.99 instead of 10
  - links with value pricing
- Going Rate Pricing
  - In case of price leader, rivals have difficulty on competing with price
    - too high and they lose market share
    - too low and the price leader would match price and force small rival out of market
  - may follow pricing leads of rivals especially where those rivals have a clear dominance of market share
  - where competition is limited, ‘going rate’ pricing may be applicable - banks, petrol, supermarkets, electrical goods - find similar pricing in all outlets.
- Tender pricing
  - many contracts are awarded on a tender basis
  - firms submit their price for carrying out the work
  - purchaser then chooses which represents best value
  - mostly done in secret
  - reputation is very important, quality inspite of low price
- Price Discrimination
  - Charging different price for same good in different markets
  - requires each market to be impenetrable
  - requires different price elasticity of demand in each market

    - price of air travel differs for same journey at different times of the day
- Penetration Pricing
    - Price set to ‘penetrate’ the market
    - Low price to secure high volumes
    - Typical in mass market products - chocolate bars, food stuffs, household goods, etc.
    - Suitable for products with long anticapted life cycles
    - May be useful if launching into a new market
- Cost Plus Pricing
    - used to maximize the rates of return of the company
    - also known as markup pricing
    - most firms use cost+ pricing or value based pricing
- Contribution Pricing
    - Contribution = Selling Price - Variable (direct) cost
    - Price set to ensure coverage of variable costs and a ‘contribution’ to the fixed cost
    - similar in principle to marginal cost pricing
    - break-even analysis is useful in such case
- Target Pricing
    - Setting price to ‘target’ a specified profit level
    - estimates of the cost and potential revenue at different prices, and thus break even have to be made, to determine the markup
    - markup = $\frac{\text{Profit}}{\text{Cost}} \times 100$
- Marginal Cost Pricing
    - Marginal Cost - the cost of producing one extra or one fewer item
    - MC pricing - allows flexibility

    - Particularly relevant in transport where fixed costs may be relatively high
    - allows a variable pricing structure - eg. on a flight from London to New York - providing the cost of the extra passenger is covered, the price could be varied a good deal to attract customers and fill the aircraft

$$\text{MC} = \frac{\Delta \text{Total Cost}}{\Delta \text{Output}}$$

- Absorption Cost Pricing
    - Full Cost Pricing - attempting to set pricing to cover both variable and fixed costs
    - Absorption Cost Pricing - Price set to absorb some of the fixed cost of production
- Destroyer Pricing
    - Deliberate price cutting or offer of ‘free gifts/prodcuts’ to force rivals (normally smaller or weaker) out of business or prevent new entrants
    - anti-competitive and illegal if it can be proved

Analyzing Firm Performance

Financial Analysis

- Assessment of the firm’s past, present, and future financial conditions
- Done to find firm’s financial strengths and weaknesses
- Primary Tools:
    - Financial Statements
    - Comparisions of financial ratio to past, industry, sector, and all firms

Financial Statements

- Balance Sheet
- Income Statement
- Cashflow Statement
- Statement of Retained Earnings

Ratio Analysis

- Standardize financial information for comparisons
- evaluate current operations
- compare performance with past performance
- compare performance against other firms or industry standards
- study the effeciency of operations
- study the risks of operations

Some common ratios:

- **Liquidity Ratio** - the ability of a firm to pay its debts
- **Investments/Shareholders Ratio** - informations to enable decisions to be made on the extent of the risk and the earning potential of a business investment
- **Gearing Ratio** - information on the relationship between exposure of the business to loans as opposed to share capital
- **Profitability Ratio** - How effective the firm is at generating profits given sales and or its capital assets
- **Financial Ratio** - the rate at which the company sells its stock (inventory) and the efficiency with which it uses its assets

Liquidity Ratios:

Acid Test (Quick Ratio)

$$\frac{(\text{Current Assets} - \text{Stock})}{\text{Liabilities}}$$

- 1:1 seen as ideal
- The omission of stock gives an indication of the cash the firm has in relation to its liablities

Current Ratio

- Ratio between current assets and current liabilities

$$\frac{\text{Current Assets}}{\text{Current Liabilities}}$$

- Ideal level is 1.5:1

Investment and Shareholder Ratios:

Earnings per Share

$$\frac{\text{Profit after tax}}{\text{number of shares}}$$

Price earnings ratio

$$\frac{\text{Market Price}}{\text{Earning Per Share}}$$

- the higher the better
- comparision with other firms helps to identify value placed on the market of the business

EV/EBITDA Ratio

$$\frac{\text{Enterprise Value}}{\text{EBITDA}}$$

- the higher the better
- it measures the operational performance of the firm

Dividend yield

$$\frac{\text{Ordinary Share Dividend}}{\text{Market Price}} \times 100$$

- the higher the better
- relates the return of investment to the share price

Gearing Ratio

$$\frac{\text{Long Term Loans}}{\text{Capital employed}} \times 100$$

- the higher the ratio, the more the firm is exposed to interest rate fluctuations and to having to pay back interest and loans before being able to re-invest earnings.

Profitability Ratio

- Profitablity measures look at how much profit the firm generates from sales or from its capital assets
- Different measures of profit - gross and net
- **Gross Profit** - effectively total revenue (turnover) - variable costs (cost of sales)

- **Net Profit** - effectively total revenue (turnover) - variable costs and fixed costs (overheads)

Gross Profit Margin

$$\frac{\text{Gross Profit}}{\text{Turnover}} \times 100$$

- The higher the better
- Enables the firm to assess the impact of its sales and how much it cost to generate those sales
- A gross profit margin of 45% means that for every 1 Rs. of sales, the firm makes $45p$ in gross profit.

Net Profit Margin

$$\frac{\text{Net Profit}}{\text{Turnover}} \times 100$$

- Net profit takes into account the fixed costs involved in production - the overheads
- Keeping control over fixed costs is important - coud be easy to overlook for example the amount of waste - paper, stationery, lighting, heating, water, etc.
    - eg. leaving a photocopier on overnight uses enough electricity to make 5300 A4 copies (1934500 per year)
    - 1 ream = 500 copies, 1 ream = Rs. 5
    - Total cost = Rs. 19345 per year

Return on Capital Employed (ROCE)

$$\frac{\text{Profit}}{\text{Capital Employed}} \times 100$$

- The higher the better
- Shows how effective the firm is in using its capital to generate profit
- Partly a measure of efficiency in organizeation and use of capital

Asset Turnover Ratio

$$\frac{\text{Sales Turnover}}{\text{Assets Employed}}$$

- Using assets to generate profit
- $\text{Asset turnover} \times \text{Net profit Margin} = \text{ROCE}$

as

$$\text{Asset Turnover Ratio} = \frac{\text{Sales Turnover}}{\text{Assets Employed}}$$
$$\text{Net Profit Margin} = \frac{\text{Net Profit}}{\text{Turnover}} \times 100$$

Stock Turnover Ratio

$$\frac{\text{Cost of Goods sold}}{\text{Stock expressed as times per year}}$$

- The rate at which a company's stock is turned over
- A high stock turnover might mean increased efficiency
    - but dependent on the type of business - supermarkets might have high stock turnover ratios whereas a shop selling high value musical instruments might have low stock turnover ratio

    - low stock turnover ratio could mean poor customer satisfaction if people are not buying the goods

Debtor Days

$$\text{Debtor Days} = \frac{\text{Debtors}}{\text{Sales Turnover}} \times 365$$

- Shorter the better
- Gives a measure of how long it takes the business to recover debts
- can be skewed by the degree of credit facility a firm offers

Industries

Tags	BDM, Concentration indices, HHI, IIP, Industries, NIC, PMI, Porter's five forces
Course	BDM
# Week	4
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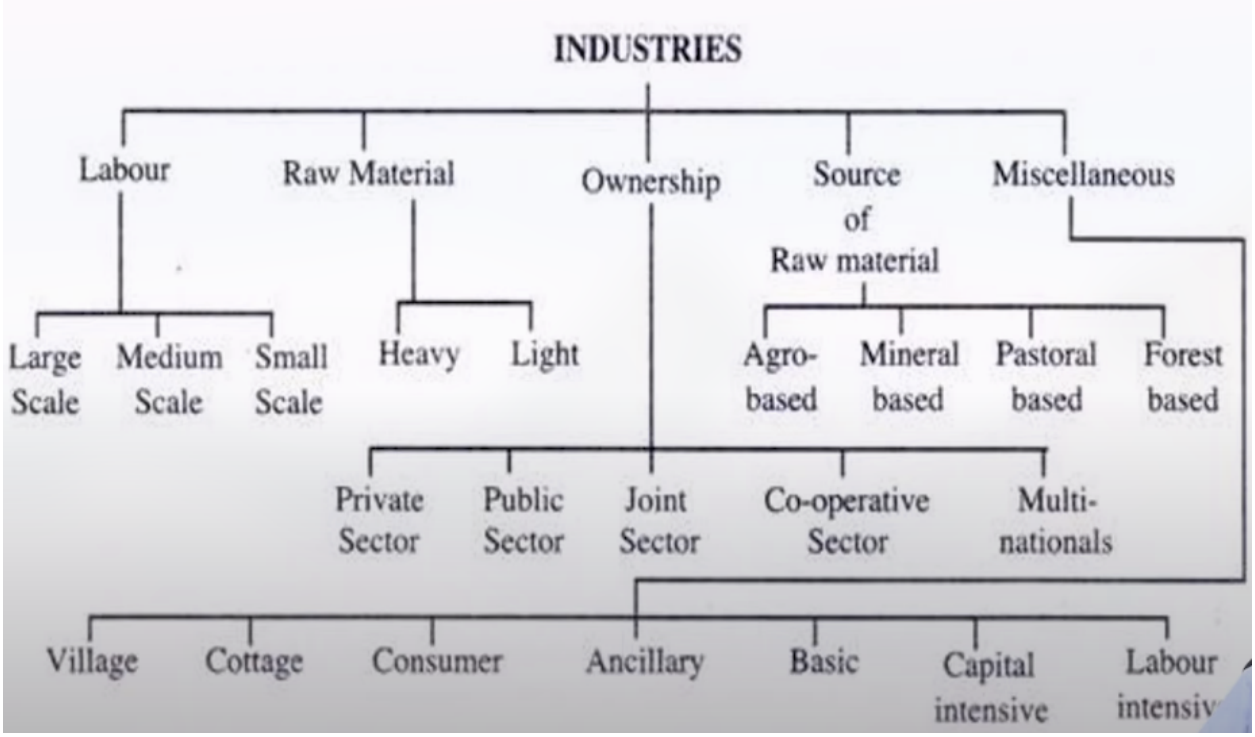
Industries

Industry is a collection of firms. Now that we have analyzed firms individually, we analyse industry as a whole.

Types of industries:



What Are Porter's Five Forces?

Porter's Five Forces is a model that identifies and analyzes five competitive forces that shape every industry and helps determine an industry's weaknesses and strengths. Five Forces analysis is frequently used to identify an industry's structure to determine corporate strategy.

Porter's 5 forces are:

1. Competition in the industry - if more competitive market, you follow market pricing instead of setting your own price if cost of switching is low and customer is not loyal
2. Potential of new entrants into the industry - if easy to enter markets than existing firms face risk of losing market
3. Power of suppliers - if supplier can set terms you lose ability to lower cost if number of suppliers is less
4. Power of customers - if customers can set terms, you lose ability to increase price if number of buyers is less
5. Threat of substitute products - if close substitutes exists, you cannot increase price too much if cost of substitution of customer is less.

Concentration Ratio

Every firm in a industry has a share of the entire market in output or revenue. This is called the **market share**. To see how monopolistic an industry is, we use some concentration indices like concentration ratio and HHI to find out how much of the market share is taken by a few firms.

Concentration Ratio → The ratio of market share of top n firms. Usually taken as 4.

$$\text{Herfindahl-Hirschman Index} = S_1^2 + S_2^2 + S_3^2 + \ldots + S_n^2$$

$$n - \text{firm concentration ratio} = S_1 + S_2 + S_3 + \ldots + S_n$$

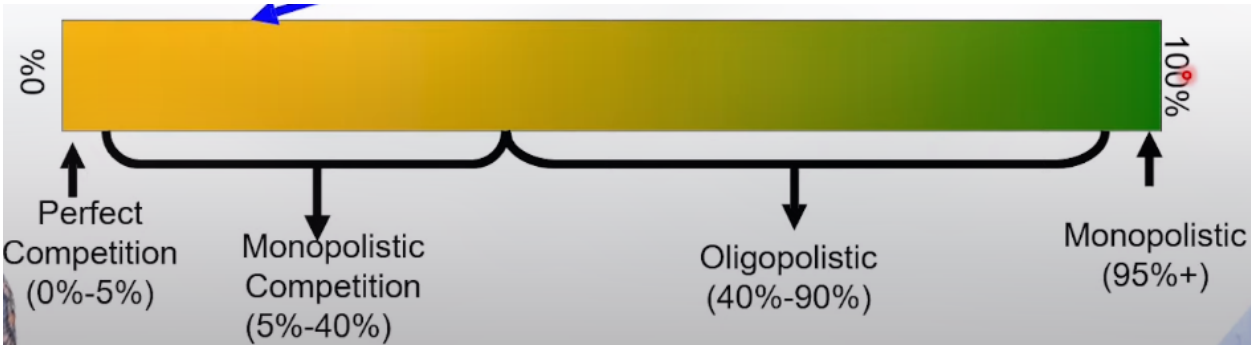
S = Market Share

Company	Market share
1	33%
2	22%
3	15%
4	12%
5	8%
6	7%
7	3%
Total	**100%**

4-companies Concentration Ratio
= 33% + 22% +15% + 12% = 82%

Herfindahl-Hirschman Index
= $33\%^2 + 22\%^2 + 15\%^2 + 12\%^2 + 8\%^2 + 7\%^2 + 3\%^2$ = 20,64% or 2064

If conc. ratio is more, market is more monopolistic, if its less, its perfectly competitive.

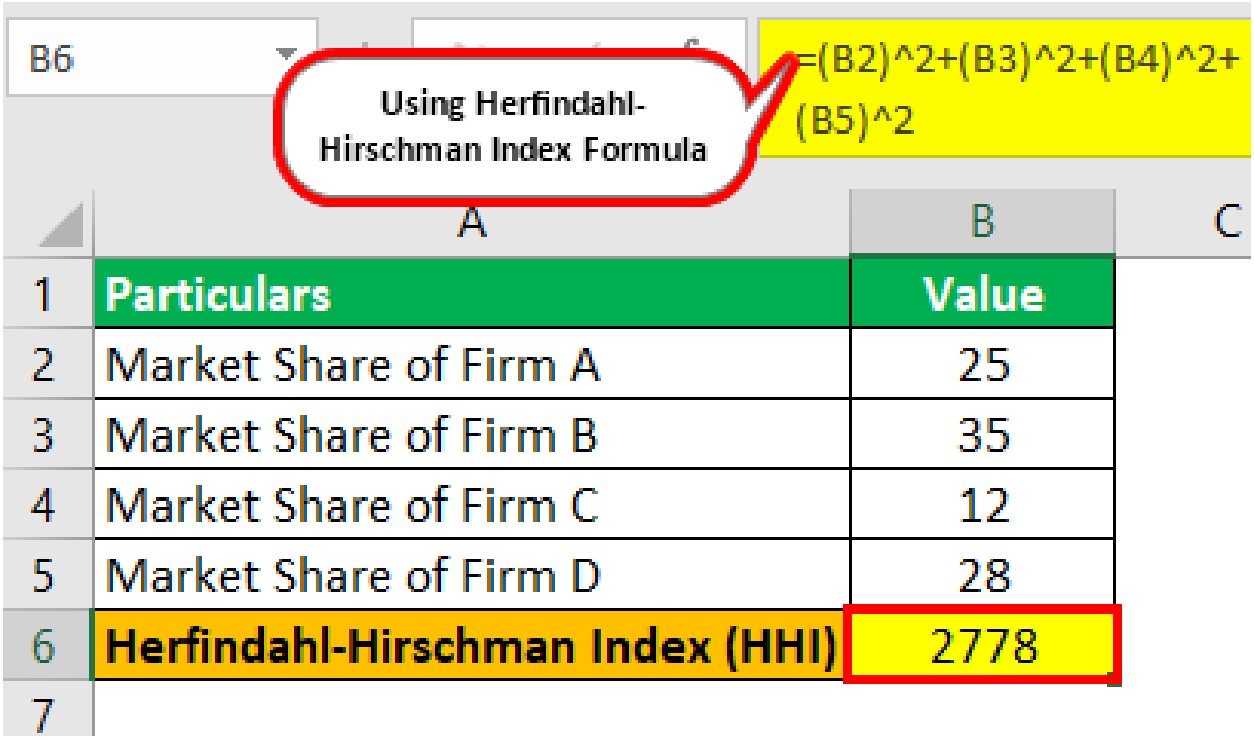


HHI (Herfindahl-Hirschman Index)

In concentration ratio its hard to figure out if top n has x% market share then how much of that is evenly distrbuted among those n. So we use HHI instead. Here we take market share of all the firms and square it, then we add it.

Herfindahl-Hirschman Index

$$HHI = S1^2 + S2^2 + S3^2 + ... Sn^2$$



	A	B	C
1	**Particulars**	**Value**	
2	Market Share of Firm A	25	
3	Market Share of Firm B	35	
4	Market Share of Firm C	12	
5	Market Share of Firm D	28	
6	**Herfindahl-Hirschman Index (HHI)**	2778	
7			

The range is from 0 to 10,000. The interpretation of the ranges of low medium and high concentration varies, but is generally like:

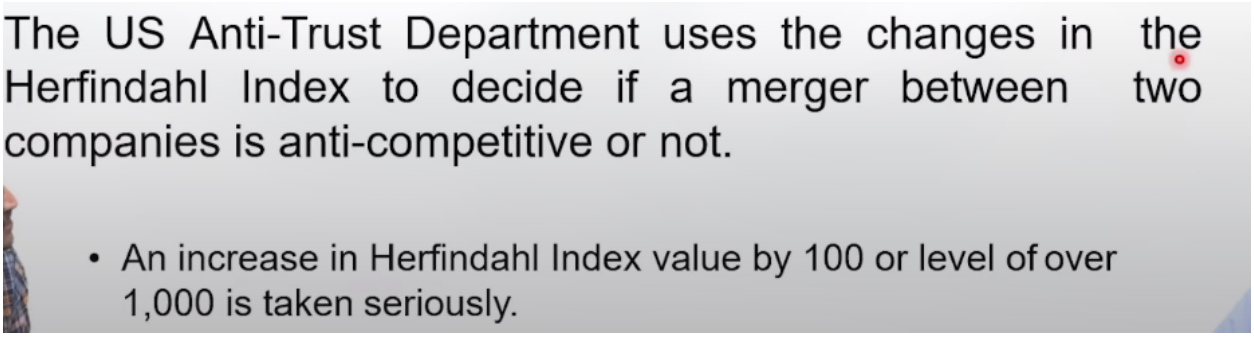
Concentration Degree	HHI	
	European Commission	Department of Justice
Low	[0–1000]	[0–1500]
Medium	[1000–2000]	[1500–2500]
High	[2000–10,000]	[2500–10,000]

Source: Calkins [37].

In lectures professor states **1000-1800** as edge of medium concentration.

Where its used?

To calculate anti-competitiveness of an industry or firm. To decline merger requests if merger is anti-competitive.



Relationship between characteristics and monopoly

Characteristic	Perfect Competition	Monopolistic Competition	Oligopoly	Pure Monopoly
Number of firms	Many	Large number	Few	One
Relationship with industry	Each firm is an insignificant part of industry	Each firm is a small share of industry	Large firms that dominate the industry	Monopoly is the Industry
Pricing power	None (Firms are price takers)	Limited	Control, with mutual interdependence	Monopolist is a price maker
Product characteristic	Standard or Homogenous	Differentiated (typically by heavy advertising)	Either Homogenous (steel) or Differentiated (Autos)	Product has no substitutes
Barriers to entry	Virtually none	Relatively easy	Relatively hard	Substantial (often insurmountable) barriers to entry
Demand curve	Perfectly Elastic (Horizontal)	Highly Elastic	"Kinked"	Downward sloping

E-Commerce, Pareto Analysis, Trends

Tags	80-20 E-commerce portfolio analysis revenue pareto scatter plot trend analysis volume pareto
Course	BDM
# Week	5
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E-Commerce

What is ecommerce? Ecommerce is **a method of buying and selling goods and services online**.

There are three main types of e-commerce:

- **business-to-business (websites such as Shopify),**
- **business-to-consumer (websites such as Amazon, Flipkart),**
- **and consumer-to-consumer (websites such as eBay, OLX)**

Problems of ECommerce

- There is a lot of data in e-commerece as entire thing is electronic
- A huge amount of inventory and stock is there
- Require to constantly monitor if something is out of stock
- Coordinate supply chain with logistics
- Being a **platform** company which deals with multiple categories of items, logistics is very hard compared to specialised ecommerce companies

Types of Products:

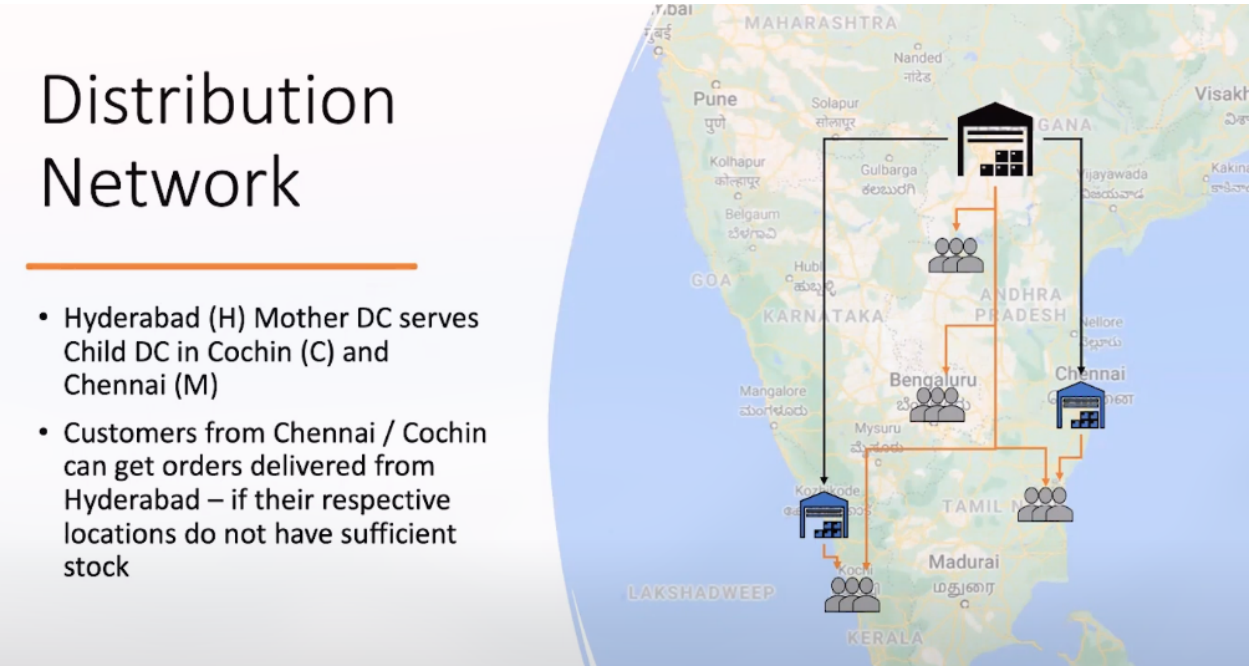
BU	Brand	Type
Mobiles	RealU	Aspriational Entry Brand
Mobiles	YouM	Economy Brand
Mobiles	Sumsang	Aspirational Brand
Mobiles	Orange	Permium Brand
FMCG	Babaji	Local Product - new entry
FMCG	Vedic	Local Product - Established quality
FMCG	Gear	MNC Product
Lifestyle	Jeera	International Men's clothing
Lifestyle	Viva	International Women's clothing

💡 **BU: Business unit**, a division within a company, as in strategic business unit.

Products are different in terms of how frequently they are bought and how long the customer thinks before buying it. Low value high frequency items like FMCG items are bought regularly and without much thought, whereas high value low frequency items like a mobile phone are bought by a user once two years and after careful research.

Distribution Network

In a supply chain, a distribution network is **an interconnected group of storage facilities and transportation systems that receive inventories of goods and then deliver them to customers**.



DC: Distribution Center - A distribution center for a set of products is a warehouse or other specialized building, often with refrigeration or air conditioning, which is stocked with products to be redistributed to retailers, to wholesalers, or directly to consumers.

Mother DC sends inventory to the child DC.

Promise:

As soon as customer inputs their pincode they are shown a promised delivery time which is calculated by analyzing the stock of the nearest DC and assiging each ordered product a DC which will fullfil the order. Usually closer DC are assigned unless they are out of stock in that product.

MOQ

MOQ stands for Minimum Order Quantity and is **the smallest number of items a supplier will accept for an order**. EOQ is based on the cost of ordering and holding, while MOQ is based on the supplier's requirements.

> 💡 MOQ is dictated by the **suppliers.**

> 💡 High value items like mobiles have a MOQ of 1, whereas low value items like FMCG have MOQ of usually entire box.

SKU

In inventory management, a **stock keeping unit** is the unit of measure in which the stocks of a material are managed. Or to put it another way; it is a distinct type of item for sale, purchase, or tracking in inventory, such as a product or service, and all attributes associated with the item type that distinguish it from other item types (for a product, these attributes can include manufacturer, description, material, size, color, packaging, and warranty terms). When a business records the inventory of its stock, it counts the quantity it has of each unit, or SKU.

Why two-tier architecture?

Due to MOQ from supplier end. If we require 60 units in DC 1, 20 units in DC 2, and 20 units in DC 3, but MOQ is 100, then buying 100 units in each three DC will cost more and have additional stock laying around, instead we set DC 1 as mother DC who buys 100 units and then keeps 60 of them and sends 20 each to the other DC.

Replenishment

restoration of a stock or supply to a former level or condition.

Replenishment Frequency

The frequency with which stock is replenished in a DC.

So with a two-tier architecture we can reduce the replenishment frequency of all child DC by having daily movement of stock from parent to child, regardless of the RF set by the supplier to the parent DC.

Stockout

a situation in which an item is out of stock. This causes loss of business and revenue.

The Requirement

- Smooth growth of revenue and efficient operations
- Ensure no stock-outs in any DC (buy additional inventories) and all demanded items are available and available in the right DC
- Control inventory so that a huge amount of assets is not locked in inventory

As evident, point 2 and 3 are contradicting each other. The Head of Planning will want to keep additional inventory to prevent stock-out but the CFO will want to reduce additional inventory to reduce the stuck assets.

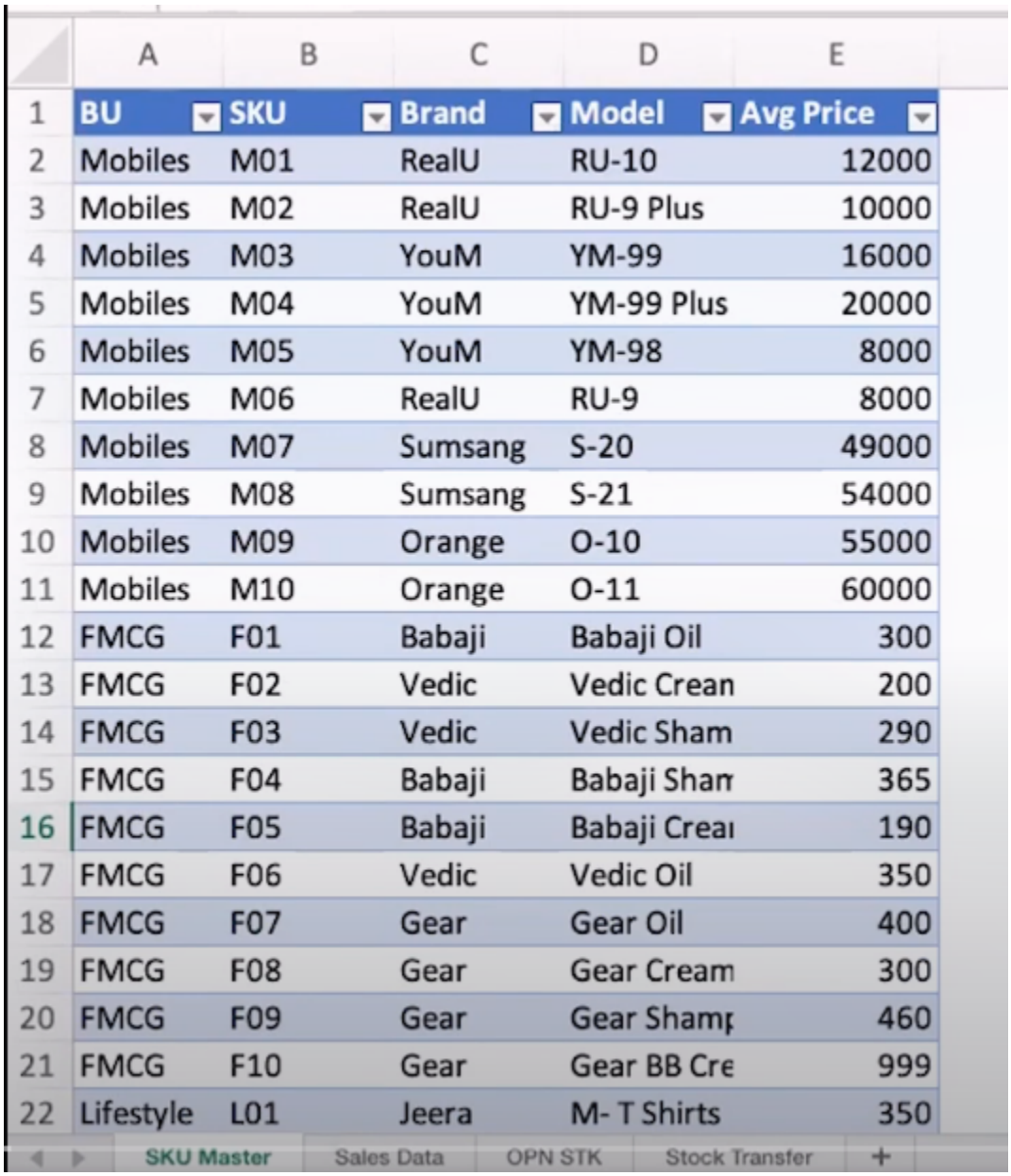
Things to analyze

- How efficient is the delivery network
- What is revenue run rate
- How much is inventory
- Are all SKU available to the customer?

Dataset

Lets look at the data we have at hand. We have four sheets of data.

1. First one is a list of all the SKUs we have. *SKU Master*

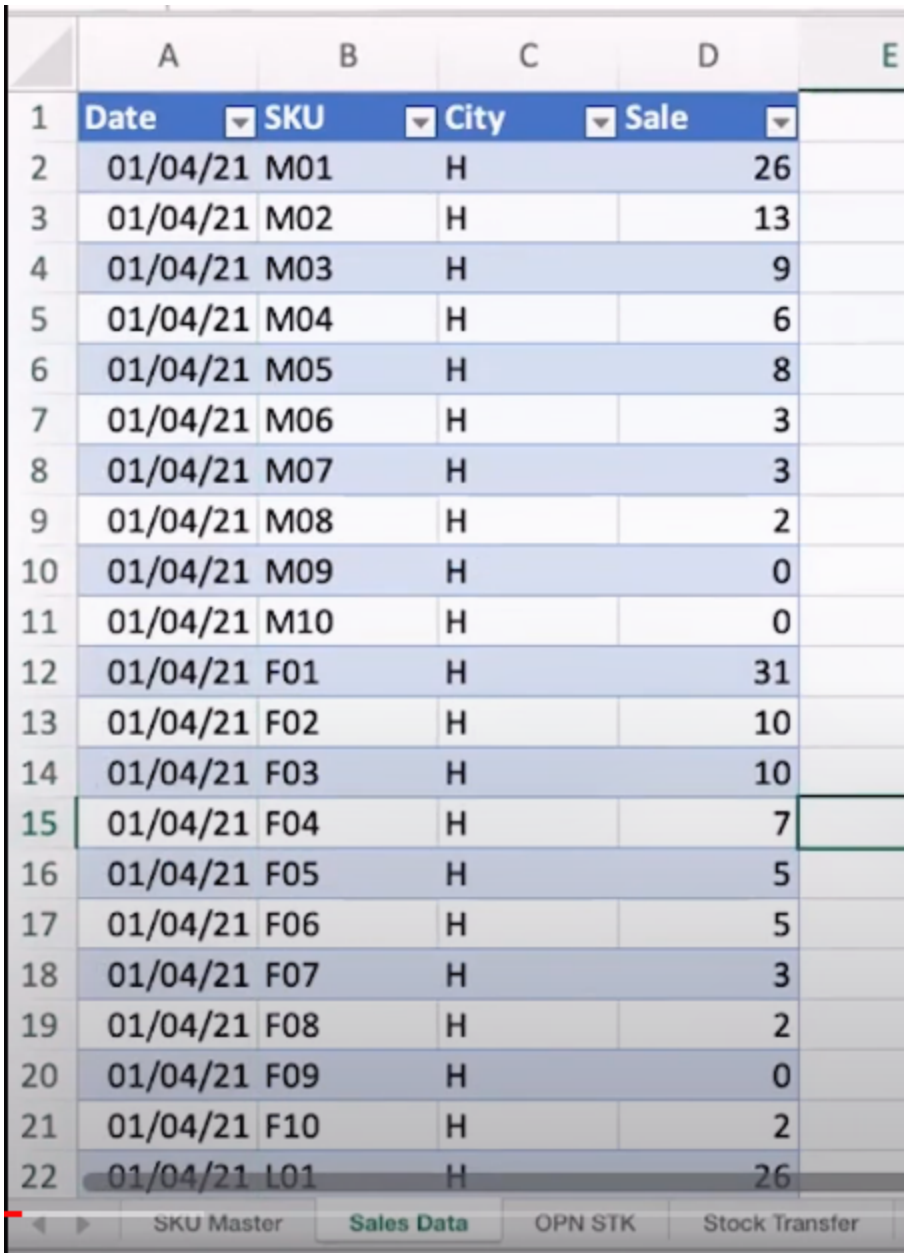


	A	B	C	D	E
1	BU	SKU	Brand	Model	Avg Price
2	Mobiles	M01	RealU	RU-10	12000
3	Mobiles	M02	RealU	RU-9 Plus	10000
4	Mobiles	M03	YouM	YM-99	16000
5	Mobiles	M04	YouM	YM-99 Plus	20000
6	Mobiles	M05	YouM	YM-98	8000
7	Mobiles	M06	RealU	RU-9	8000
8	Mobiles	M07	Sumsang	S-20	49000
9	Mobiles	M08	Sumsang	S-21	54000
10	Mobiles	M09	Orange	O-10	55000
11	Mobiles	M10	Orange	O-11	60000
12	FMCG	F01	Babaji	Babaji Oil	300
13	FMCG	F02	Vedic	Vedic Crean	200
14	FMCG	F03	Vedic	Vedic Sham	290
15	FMCG	F04	Babaji	Babaji Sham	365
16	FMCG	F05	Babaji	Babaji Creai	190
17	FMCG	F06	Vedic	Vedic Oil	350
18	FMCG	F07	Gear	Gear Oil	400
19	FMCG	F08	Gear	Gear Cream	300
20	FMCG	F09	Gear	Gear Shamp	460
21	FMCG	F10	Gear	Gear BB Cre	999
22	Lifestyle	L01	Jeera	M- T Shirts	350

SKU Master | Sales Data | OPN STK | Stock Transfer | +

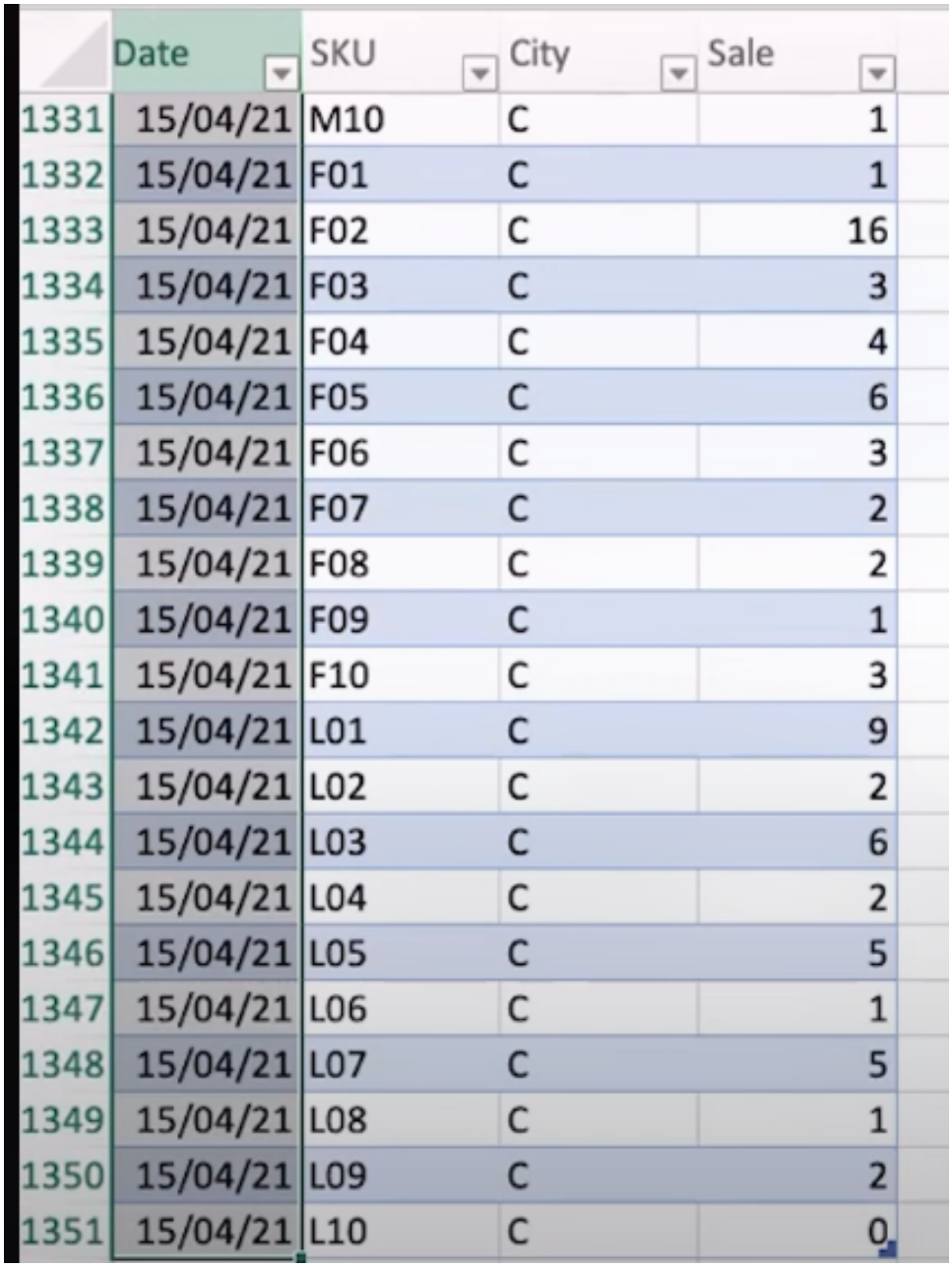
19	FMCG	F08	Gear	Gear Cream	300
20	FMCG	F09	Gear	Gear Shamp	460
21	FMCG	F10	Gear	Gear BB Cre	999
22	Lifestyle	L01	Jeera	M- T Shirts	350
23	Lifestyle	L02	Jeera	M- Inners	400
24	Lifestyle	L03	Viva	W-Casuals	800
25	Lifestyle	L04	Viva	W-Inners	1200
26	Lifestyle	L05	Jeera	M-Jeans	1999
27	Lifestyle	L06	Jeera	M-Casuals	1200
28	Lifestyle	L07	Viva	W-Western	2500
29	Lifestyle	L08	Viva	W-Lounge	1500
30	Lifestyle	L09	Jeera	M-Formals	1800
31	Lifestyle	L10	Jeera	M-Shoes	3000

2. Next we have transactional data for each day (15 days total). *Sales Data*



	A	B	C	D	E
1	Date	SKU	City	Sale	
2	01/04/21	M01	H	26	
3	01/04/21	M02	H	13	
4	01/04/21	M03	H	9	
5	01/04/21	M04	H	6	
6	01/04/21	M05	H	8	
7	01/04/21	M06	H	3	
8	01/04/21	M07	H	3	
9	01/04/21	M08	H	2	
10	01/04/21	M09	H	0	
11	01/04/21	M10	H	0	
12	01/04/21	F01	H	31	
13	01/04/21	F02	H	10	
14	01/04/21	F03	H	10	
15	01/04/21	F04	H	7	
16	01/04/21	F05	H	5	
17	01/04/21	F06	H	5	
18	01/04/21	F07	H	3	
19	01/04/21	F08	H	2	
20	01/04/21	F09	H	0	
21	01/04/21	F10	H	2	
22	01/04/21	L01	H	26	

SKU Master | Sales Data | OPN STK | Stock Transfer



	Date	SKU	City	Sale
1331	15/04/21	M10	C	1
1332	15/04/21	F01	C	1
1333	15/04/21	F02	C	16
1334	15/04/21	F03	C	3
1335	15/04/21	F04	C	4
1336	15/04/21	F05	C	6
1337	15/04/21	F06	C	3
1338	15/04/21	F07	C	2
1339	15/04/21	F08	C	2
1340	15/04/21	F09	C	1
1341	15/04/21	F10	C	3
1342	15/04/21	L01	C	9
1343	15/04/21	L02	C	2
1344	15/04/21	L03	C	6
1345	15/04/21	L04	C	2
1346	15/04/21	L05	C	5
1347	15/04/21	L06	C	1
1348	15/04/21	L07	C	5
1349	15/04/21	L08	C	1
1350	15/04/21	L09	C	2
1351	15/04/21	L10	C	0

The City represents which DC the sale is from, and the Sale column is the quantity.

There are exactly 1350 rows, one for each combination of $date \times SKU \times city$. ($15 \times 30 \times 3$)

3. Opening Stock - the number of items of each SKU in inventory on 1st April for each DC

	A	B	C	D
1	SKU	H	C	M
2	F01	391	77	50
3	F02	200	42	30
4	F03	76	36	18
5	F04	96	23	20
6	F05	99	26	13
7	F06	62	16	6
8	F07	55	11	10
9	F08	23	6	2
10	F09	15	7	2
11	F10	39	10	2
12	L01	257	60	74
13	L02	257	34	51
14	L03	151	16	28
15	L04	108	14	27
16	L05	117	16	13
17	L06	132	12	6
18	L07	152	14	3
19	L08	44	8	2
20	L09	54	7	1
21	L10	33	3	2
22	M01	127	29	64

This will have 30 rows (one for each SKU)

4. Stock Transfer - the number of items of each SKU transferred from H DC to C and M DC everyday for the 15 days.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	STK TRNS								C						
2	SKU	01-Apr	02-Apr	03-Apr	04-Apr	05-Apr	06-Apr	07-Apr	08-Apr	09-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-A
3	F01	10	21	15	17	13	19	15	12	16	15	13	8	13	
4	F02	5	7	6	9	7	8	7	6	7	9	5	9	6	
5	F03	8	6	7	5	5	7	4	5	5	6	4	7	6	
6	F04	6	6	6	4	6	4	6	4	3	5	4	4	4	
7	F05	3	5	4	4	3	2	4	4	5	5	4	4	4	
8	F06	3	4	3	3	3	2	4	2	3	3	3	2	3	
9	F07	2	2	3	2	2	2	2	2	2	3	2	3	3	
10	F08	2	1	1	1	2	1	2	2	2	2	2	2	2	
11	F09	1	2	2	2	1	1	2	2	1	2	2	2	2	
12	F10	2	2	2	2	2	2	2	1	1	1	2	3	2	
13	L01	9	7	11	6	12	6	12	10	10	10	5	10	10	
14	L02	6	4	5	4	5	5	6	4	5	4	5	3	6	
15	L03	3	3	4	3	3	4	4	3	5	4	4	3	3	
16	L04	4	4	4	4	4	3	2	3	3	2	3	2	3	
17	L05	3	4	4	4	3	4	5	3	3	3	4	4	4	
18	L06	3	3	3	3	2	4	2	3	3	3	3	3	2	
19	L07	4	4	3	2	3	3	4	3	3	3	3	4	4	
20	L08	2	2	2	2	2	2	1	1	1	2	2	1	1	
21	L09	2	1	2	2	1	1	1	2	2	1	2	2	2	

Columns B to P is for cochin (DC C) and next 15 columns are for madras (DC M).

Analysis to be performed

Planning Head wants to know

1. Which are high volume SKUs?
2. Which SKU provides highest revenue?
3. Where should I place the high volume and high revenue SKUs in the DC? (for speed and safety of items)
4. Which are the SKU I am planning to order today?
5. Is there any trend in the volumes?
6. Which days have the highest sales?
7. Which items to stock more and where?
8. Which items to stock less and where?

CFO wants to know

1. What is the inventory holding?
2. Are there stockouts?
3. Why we are not getting stocks on M01?

CEO wants to know

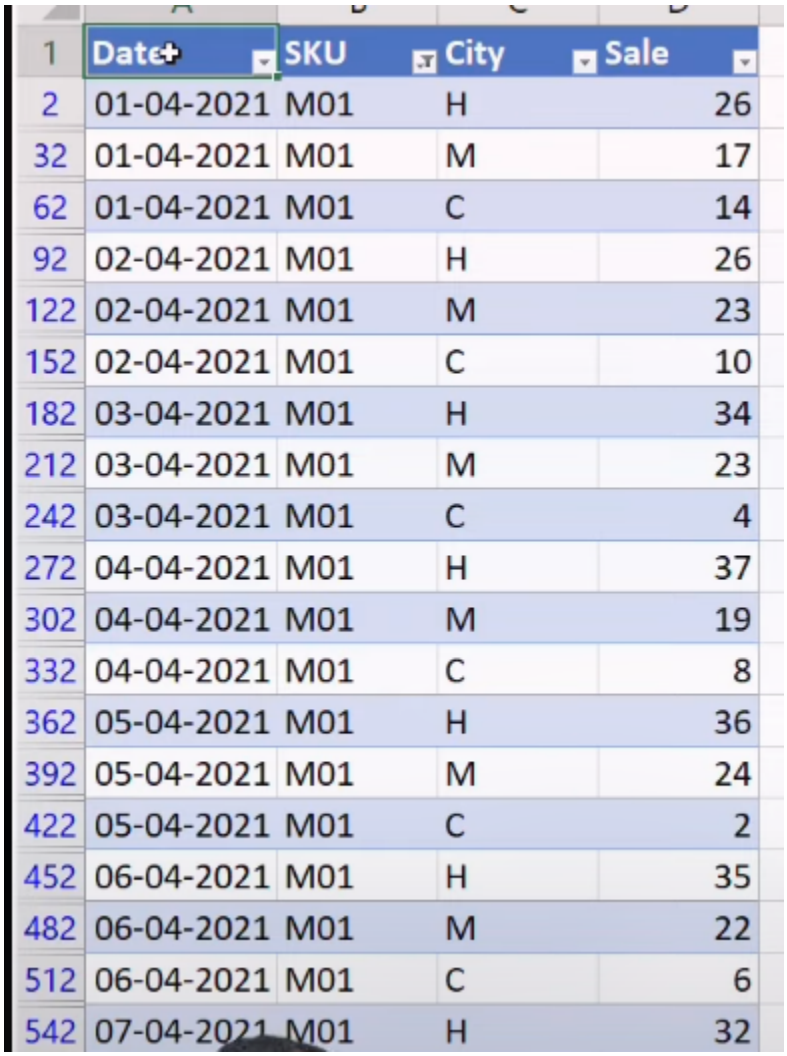
1. What is the availability for customers from forward DCs
2. What is the growth at BU level? (**BU → Business Unit:** the group of SKUs, like Fashion, or Electronics)
3. How do we plan the service levels for important SKUs (how important items are available very fast)

Usually, the frequency of buying FMCG > Fashion > Mobiles

but the price of FMCG < Fashion < Mobiles

Analysis

From the Sales data



	Date	SKU	City	Sale
2	01-04-2021	M01	H	26
32	01-04-2021	M01	M	17
62	01-04-2021	M01	C	14
92	02-04-2021	M01	H	26
122	02-04-2021	M01	M	23
152	02-04-2021	M01	C	10
182	03-04-2021	M01	H	34
212	03-04-2021	M01	M	23
242	03-04-2021	M01	C	4
272	04-04-2021	M01	H	37
302	04-04-2021	M01	M	19
332	04-04-2021	M01	C	8
362	05-04-2021	M01	H	36
392	05-04-2021	M01	M	24
422	05-04-2021	M01	C	2
452	06-04-2021	M01	H	35
482	06-04-2021	M01	M	22
512	06-04-2021	M01	C	6
542	07-04-2021	M01	H	32

We find out the total sales of each SKU for each city using **pivot tables**.

A pivot table is a table of grouped values that aggregates the individual items of a more extensive table within one or more discrete categories. This summary might include sums, averages, or other statistics, which the pivot table groups together using a chosen aggregation function applied to the grouped values.

3	Row Labels	Sum of Sale
4	F01	914
5	F02	429
6	F03	332
7	F04	274
8	F05	185
9	F06	112
10	F07	112
11	F08	38
12	F09	37
13	F10	51
14	L01	896
15	L02	457
16	L03	333
17	L04	256
18	L05	195
19	L06	110
20	L07	105
21	L08	39

For all city combined we get the above data. We then sort the data according to the sum of sales column and get the following data.

Row Label	Sum of Sale	
F01	914	12%
M01	909	12%
L01	896	12%
M02	464	6%
L02	457	6%
F02	429	6%
M03	342	5%
L03	333	4%
F03	332	4%
F04	274	4%
M04	272	4%
L04	256	3%
L05	195	3%
M05	192	3%
F05	185	2%
M06	119	2%
M07	117	2%
F06	112	2%

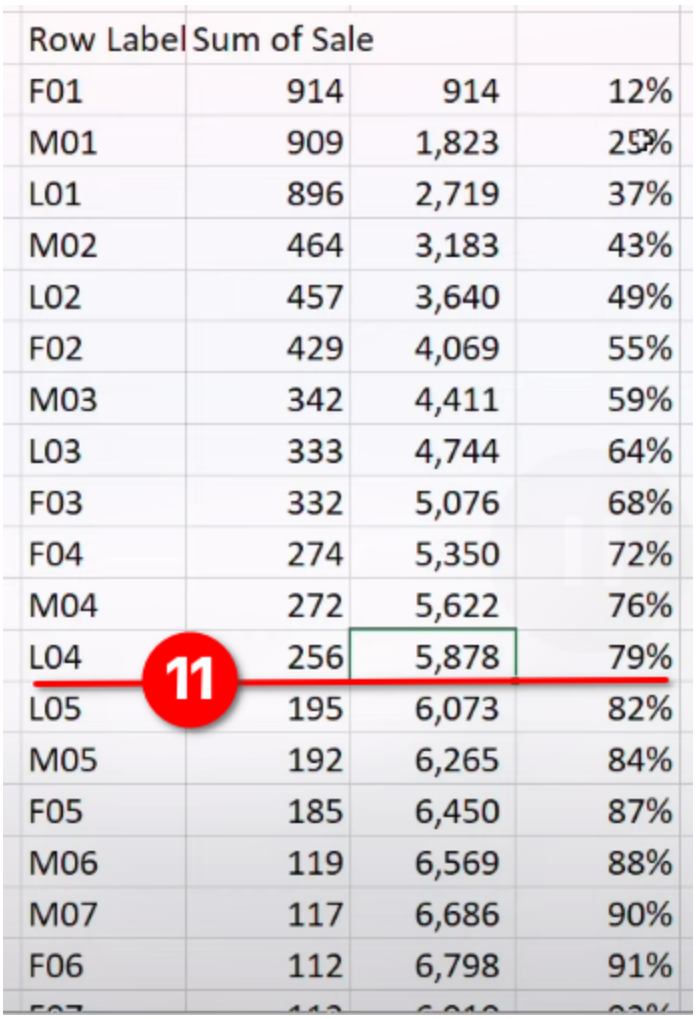
So we can find that the top volume of sales are from the **F01, M01, L01** items.

Volume Pareto Analysis

Does this follow **pareto principle?**

> 💡 **The Pareto principle** states that for many outcomes, roughly 80% of consequences come from 20% of causes. Other names for this principle are the 80/20 rule, the law of the vital few, or the principle of factor sparsity.

To find that we compute the cumulative contribution percentage and see how many top items contribute to 80% of the volume.

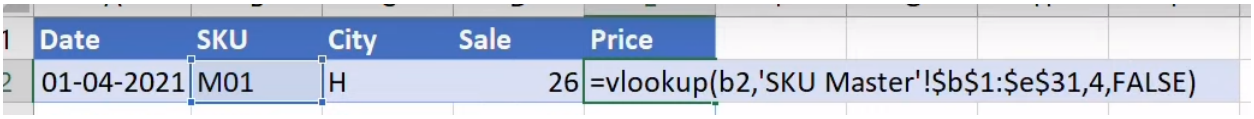


We find that the top 11 (36%) items contribute to the 80% of the volume of sales. Which does not follow pareto principle strongly.

Revenue Analysis

Now lets find which items bring in the highest revenue. But for that we need to have the price data of each SKU in the Sales Data sheet alongside the number of quantity sold for ease of calculation. We do this using **VLOOKUP.**

> 💡 VLOOKUP stands for **Vertical Lookup**. As the name specifies, VLOOKUP is a built-in Excel function that helps you look for a specified value by searching for it vertically across the sheet.



	Date	SKU	City	Sale	Price
2	01-04-2021	M01	H	26	=vlookup(b2,'SKU Master'!b1:e31,4,FALSE)

We use dollars '**$**' to ensure that we are using **absolute reference** of the range, so when we drag this formula to the cells below, the B2 changes to B3 but the range does not change.

	Date	SKU	City	Sale	Price
2	01-04-2021	M01	H	26	12000
3	01-04-2021	M02	H	13	10000
4	01-04-2021	M03	H	9	16000
5	01-04-2021	M04	H	6	20000
6	01-04-2021	M05	H	8	8000
7	01-04-2021	M06	H	3	8000
8	01-04-2021	M07	H	3	49000
9	01-04-2021	M08	H	2	54000
10	01-04-2021	M09	H	0	55000
11	01-04-2021	M10	H	0	60000
12	01-04-2021	F01	H	31	300
13	01-04-2021	F02	H	10	200
14	01-04-2021	F03	H	10	290
15	01-04-2021	F04	H	7	365
16	01-04-2021	F05	H	5	190
17	01-04-2021	F06	H	5	350
18	01-04-2021	F07	H	3	400
19	01-04-2021	F08	H	2	300

Now we have the price alongside the volume, we can multiply them to get revenue of each SKU in each DC on each day.

2	01-04-2021	M01	H	26	12000	₹ 3,12,000.00
3	01-04-2021	M02	H	13	10000	₹ 1,30,000.00
4	01-04-2021	M03	H	9	16000	₹ 1,44,000.00
5	01-04-2021	M04	H	6	20000	₹ 1,20,000.00
6	01-04-2021	M05	H	8	8000	₹ 64,000.00
7	01-04-2021	M06	H	3	8000	₹ 24,000.00
8	01-04-2021	M07	H	3	49000	₹ 1,47,000.00
9	01-04-2021	M08	H	2	54000	₹ 1,08,000.00
10	01-04-2021	M09	H	0	55000	₹ 0.00
11	01-04-2021	M10	H	0	60000	₹ 0.00
12	01-04-2021	F01	H	31	300	₹ 9,300.00
13	01-04-2021	F02	H	10	200	₹ 2,000.00
14	01-04-2021	F03	H	10	290	₹ 2,900.00
15	01-04-2021	F04	H	7	365	₹ 2,555.00
16	01-04-2021	F05	H	5	190	₹ 950.00
17	01-04-2021	F06	H	5	350	₹ 1,750.00
18	01-04-2021	F07	H	3	400	₹ 1,200.00
19	01-04-2021	F08	H	2	300	₹ 600.00
20	01-04-2021	F09	H	0	460	₹ 0.00

Now we can summarise the total revenue for each SKU (or for each city) using a pivot table.

Row Label	Sum of Revenue
M01	₹ 1,09,08,000.00
M07	₹ 57,33,000.00
M03	₹ 54,72,000.00
M04	₹ 54,40,000.00
M02	₹ 46,40,000.00
M09	₹ 22,00,000.00
M10	₹ 18,00,000.00
M05	₹ 15,36,000.00
M08	₹ 15,12,000.00
M06	₹ 9,52,000.00
L05	₹ 3,89,805.00
L01	₹ 3,13,600.00
L04	₹ 3,07,200.00
F01	₹ 2,74,200.00
L03	₹ 2,66,400.00
L07	₹ 2,62,500.00
L02	₹ 1,82,800.00
L06	₹ 1,32,000.00

Now we can see that the top revenue is brought in by the SKUs M01, M07, M03, M04. (furthermore we can see all of the ten mobile SKUs bring more revenue than anything else)

Revenue Pareto Analysis

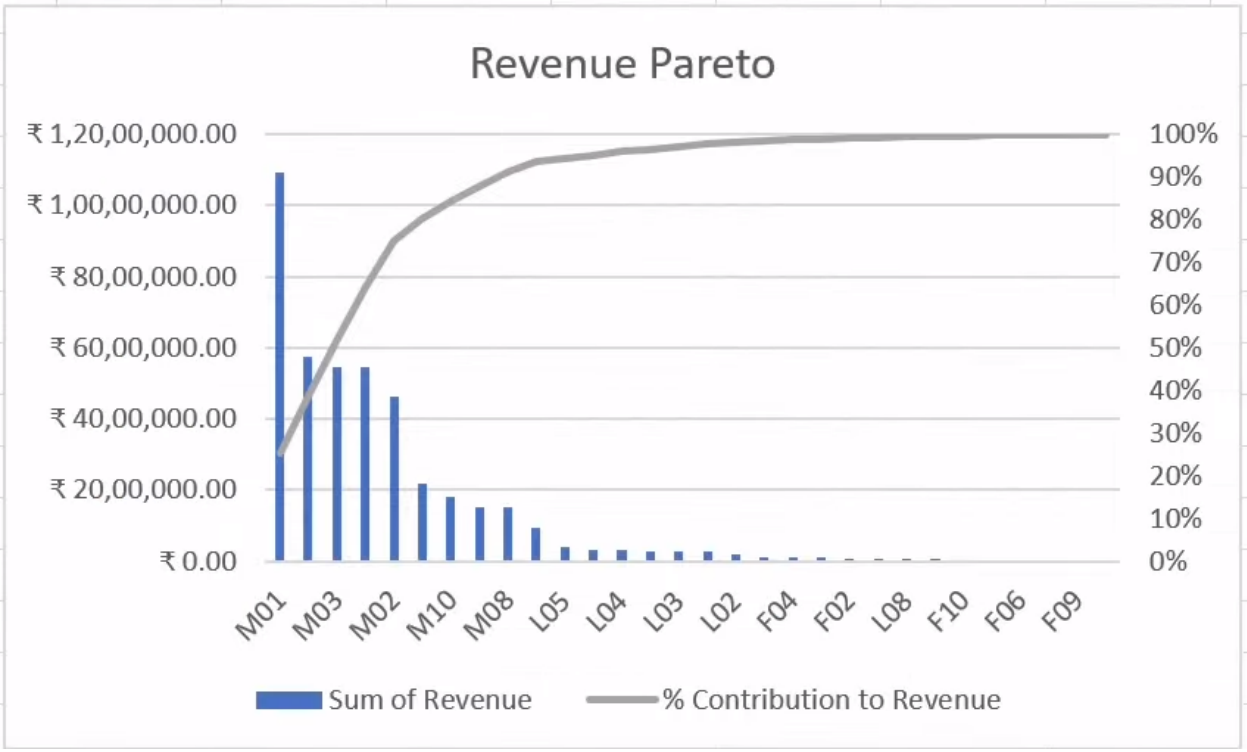
Finally, we can perform similar pareto analysis on the revenue.

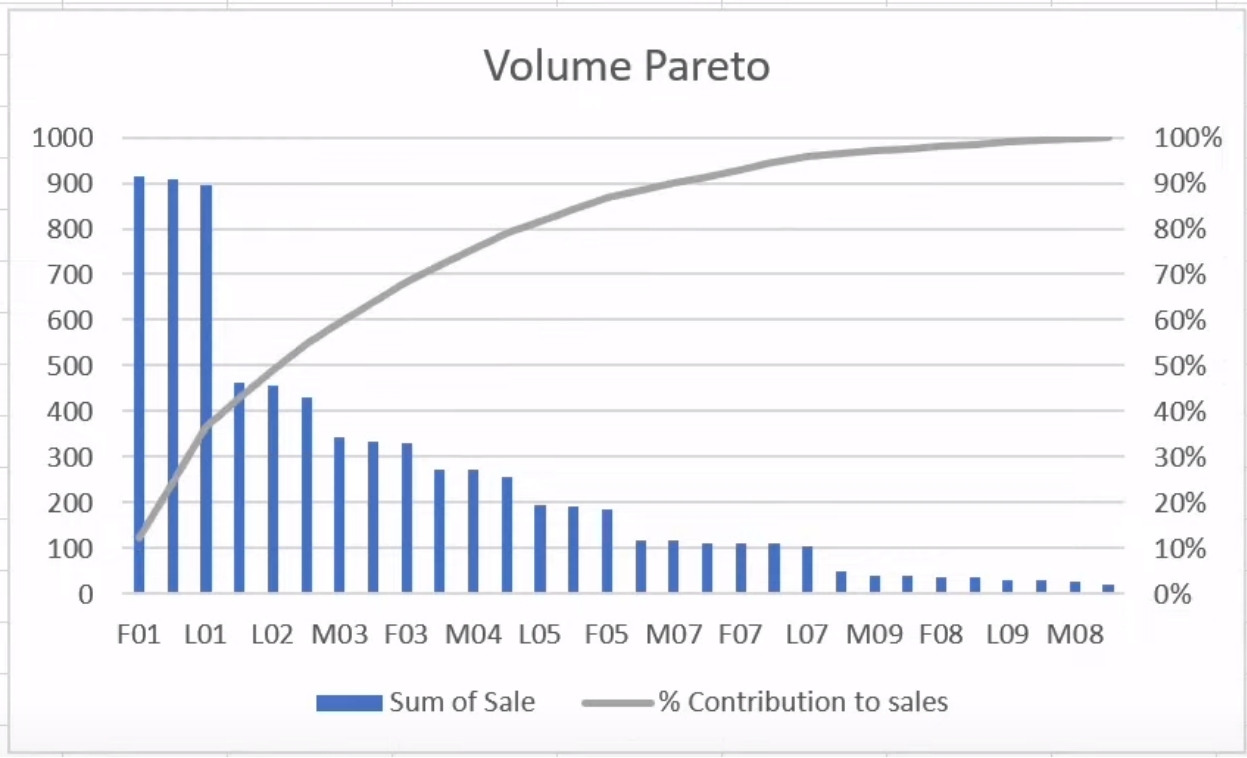
Row Label	Sum of Revenue	Cumulative revenue	
M01	₹ 1,09,08,000.00	₹ 1,09,08,000.00	25%
M07	₹ 57,33,000.00	₹ 1,66,41,000.00	39%
M03	₹ 54,72,000.00	₹ 2,21,13,000.00	51%
M04	₹ 54,40,000.00	₹ 2,75,53,000.00	64%
M02	₹ 46,40,000.00	₹ 3,21,93,000.00	75%
M09	₹ 22,00,000.00	₹ 3,43,93,000.00	80%
M10	₹ 18,00,000.00	₹ 3,61,93,000.00	84%
M05	₹ 15,36,000.00	₹ 3,77,29,000.00	88%
M08	₹ 15,12,000.00	₹ 3,92,41,000.00	91%
M06	₹ 9,52,000.00	₹ 4,01,93,000.00	94%
L05	₹ 3,89,805.00	₹ 4,05,82,805.00	94%
L01	₹ 3,13,600.00	₹ 4,08,96,405.00	95%
L04	₹ 3,07,200.00	₹ 4,12,03,605.00	96%
F01	₹ 2,74,200.00	₹ 4,14,77,805.00	97%
L03	₹ 2,66,400.00	₹ 4,17,44,205.00	97%
L07	₹ 2,62,500.00	₹ 4,20,06,705.00	98%
L02	₹ 1,82,800.00	₹ 4,21,89,505.00	98%
L06	₹ 1,32,000.00	₹ 4,23,21,505.00	98%

We see that 80% of revenue is brought in by the top 6 (20%) SKUs, thus revenue follows pareto principle exactly.

Charting the Data

We can now chart the revenue pareto and volume pareto into a chart to visualize it.



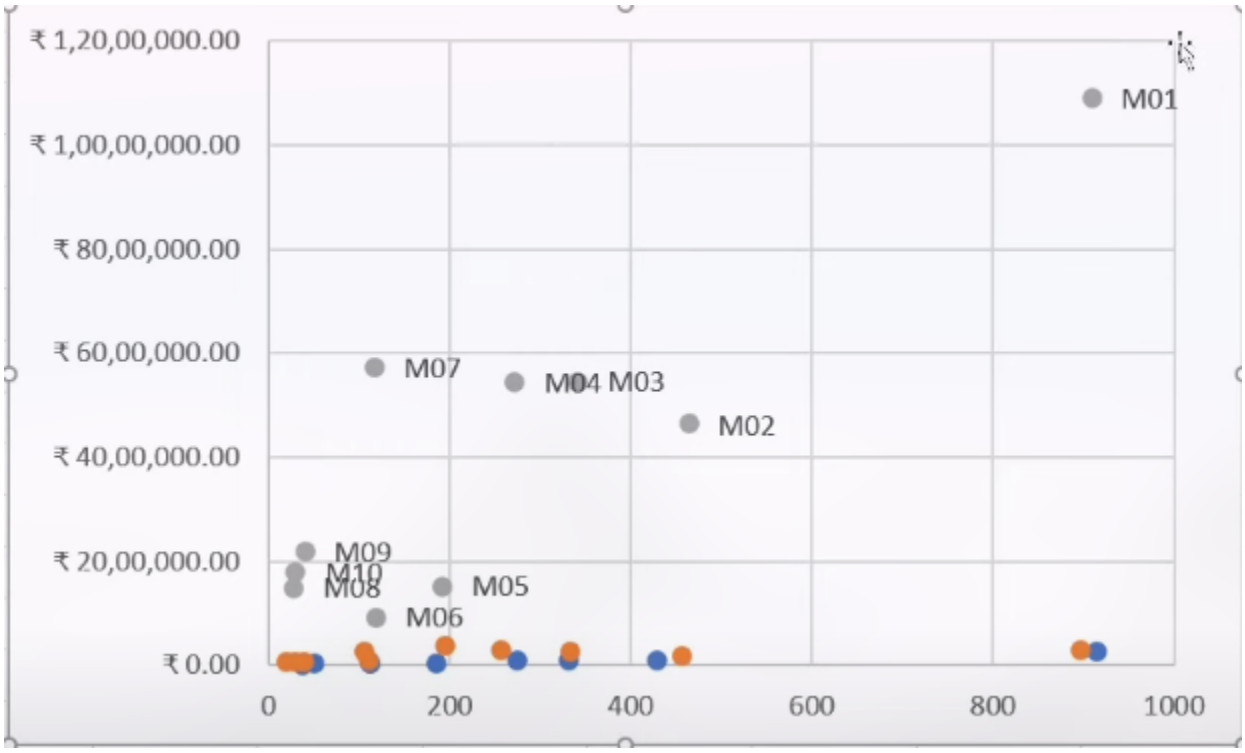


And we can clearly see that the revenue pareto is much more steeper compared to the volume pareto.

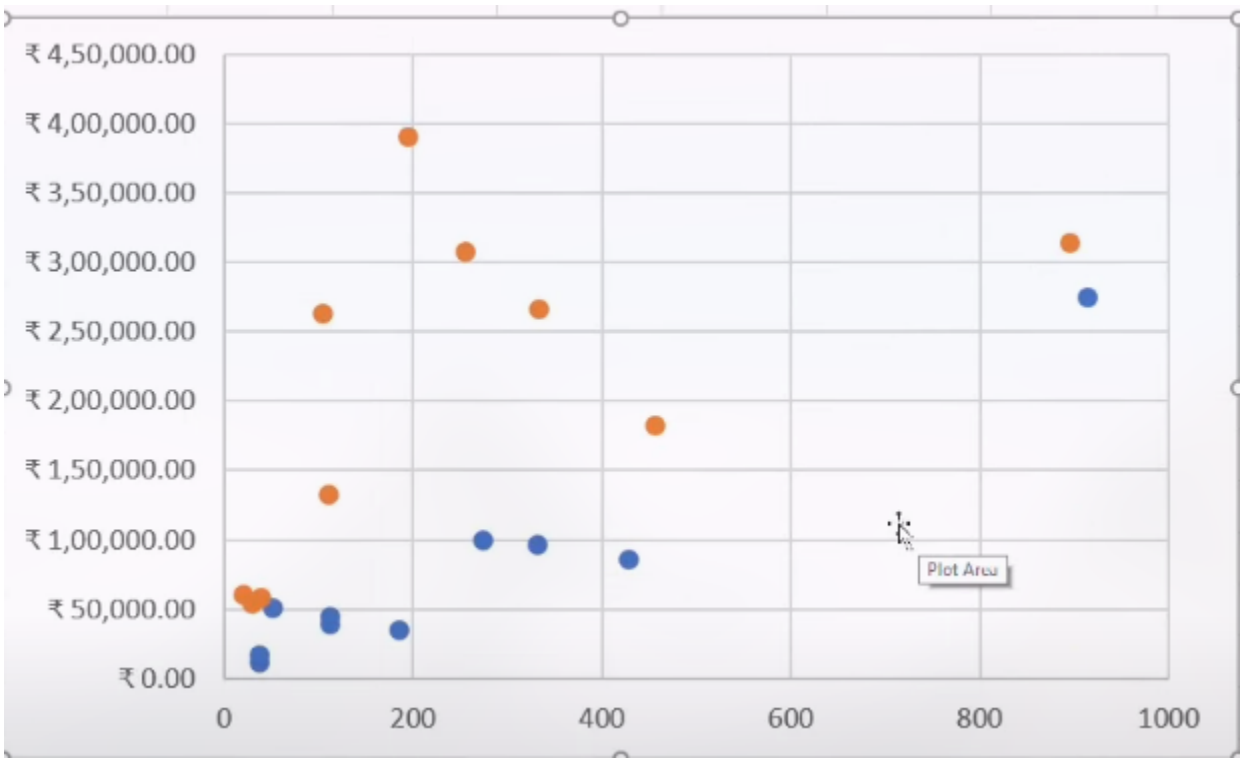
Scatter Plot Portfolio Analysis

To analyze which combinations of {High, Low} × {Revenue, Volume} are present in the data, we create a table with both the data points and create scatter plots. But as the range of values for each **BU** is very different, we add them separately with different scale.

We can see with the same scale the mobile clearly outweighs everything else:

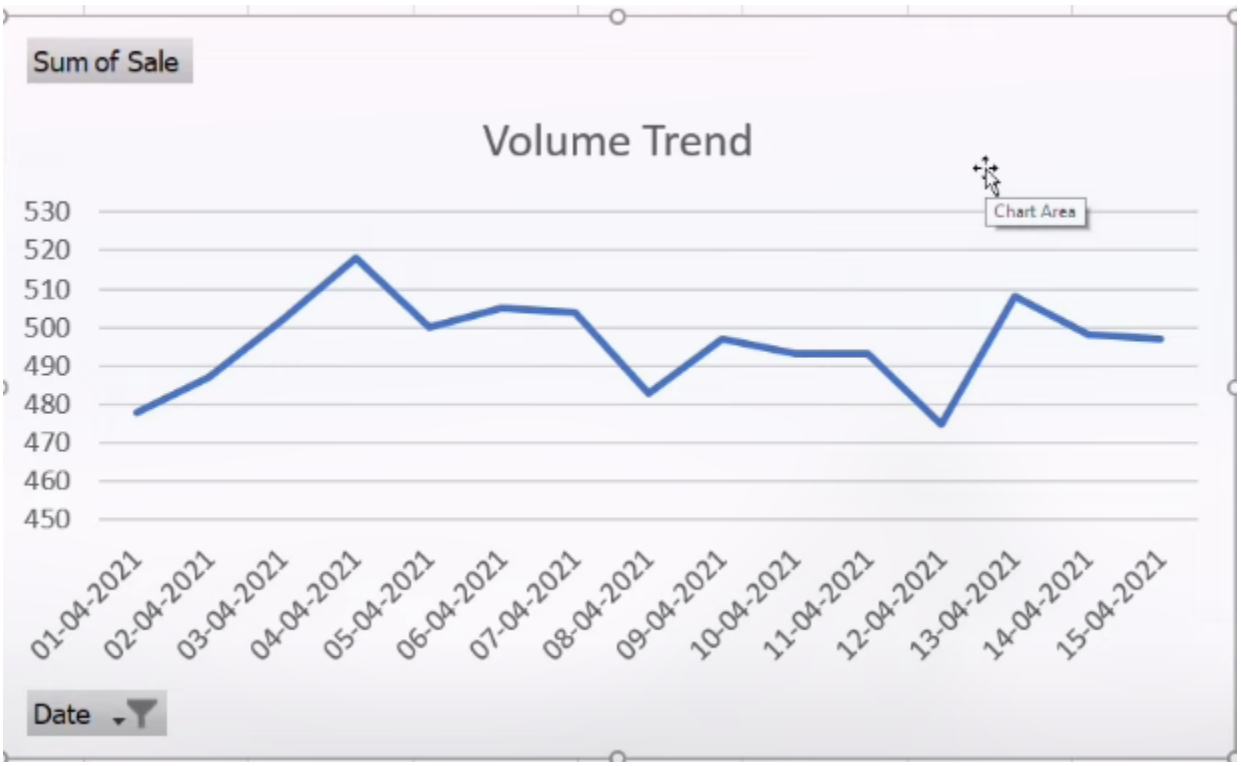


If we remove the mobiles from the data we get a clearer picture.



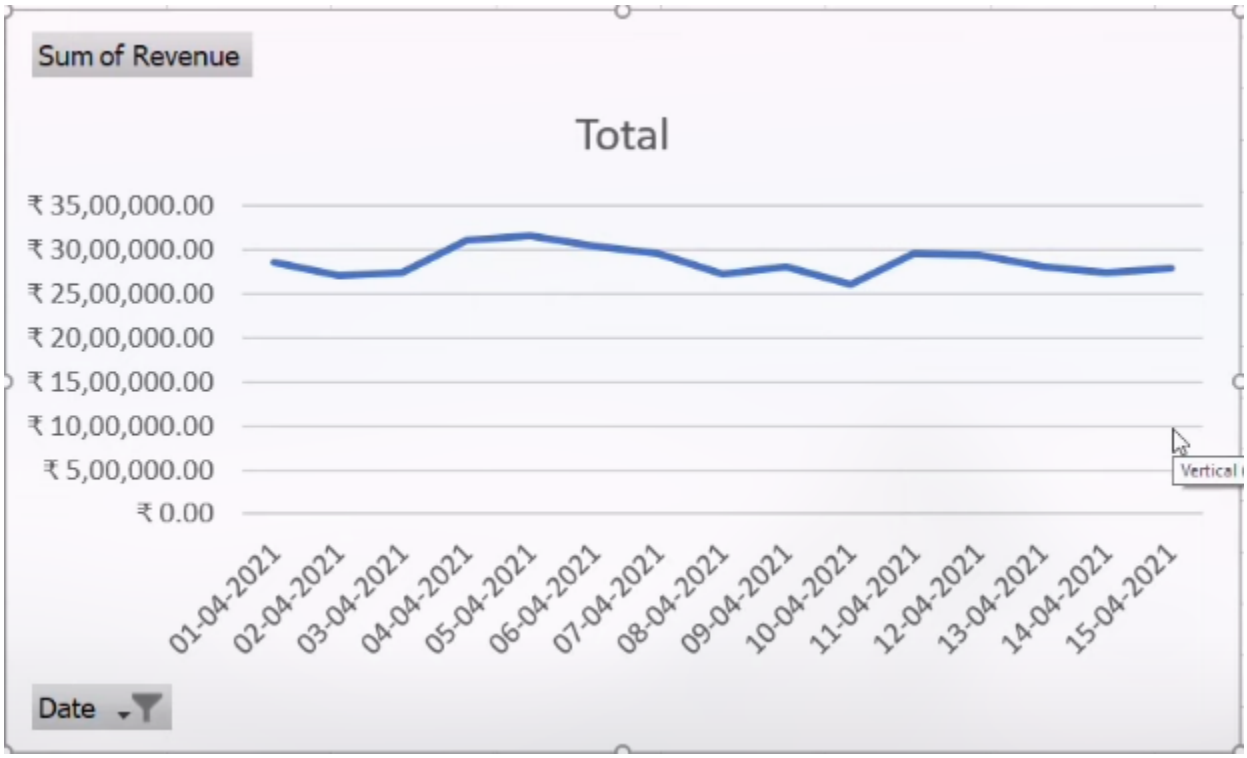
Trend Analysis

Lets analyze the volume data with respect to date. First we insert a pivot table and pivot the data with date as rows and sum of sales as values. Then we can chart the data.



We observe no clear trend.

Lets repeat this with revenue.



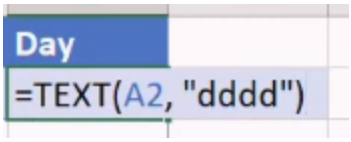
Here too there is no clearly visible trend. 15 days is not enough to see any visible trend.

Observations:

- 25-30 Lakhs of revenue per day is generated
- around 500 items are shipped daily

Weekly analysis

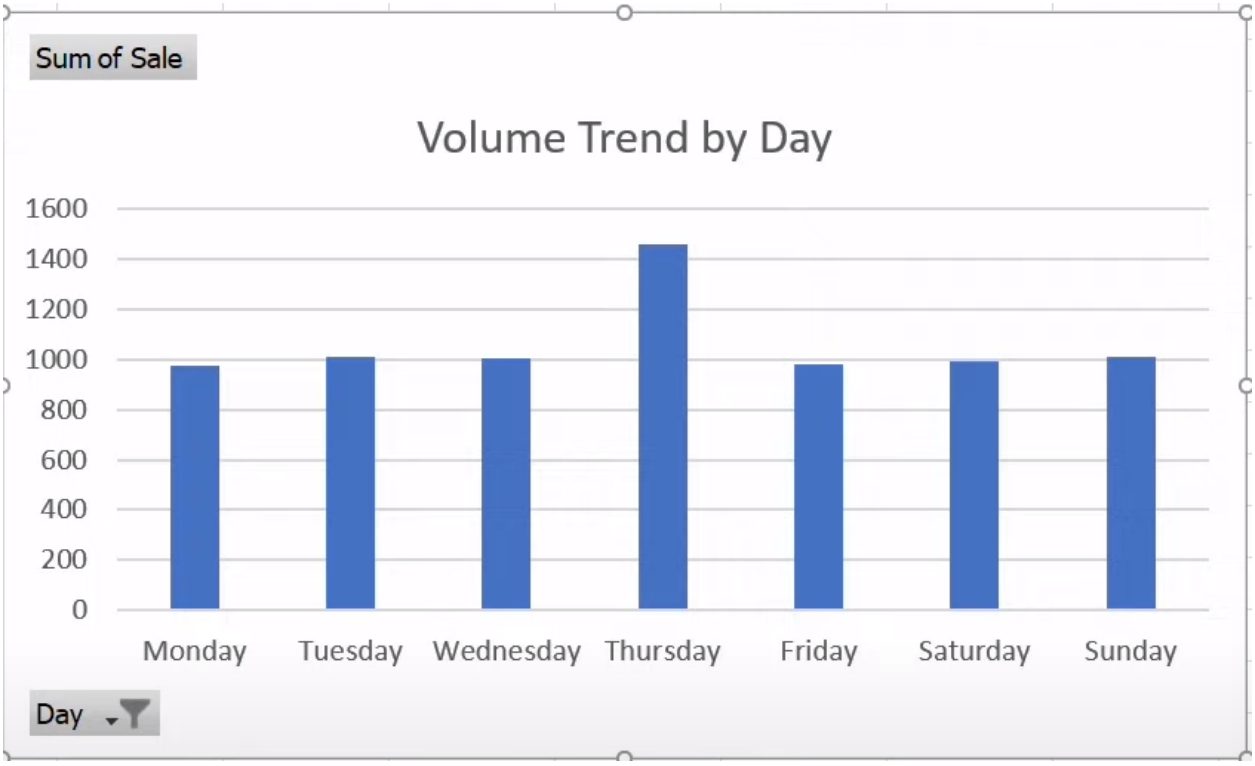
To do this first we have to add a column to the data which shows which day of the week the date is.



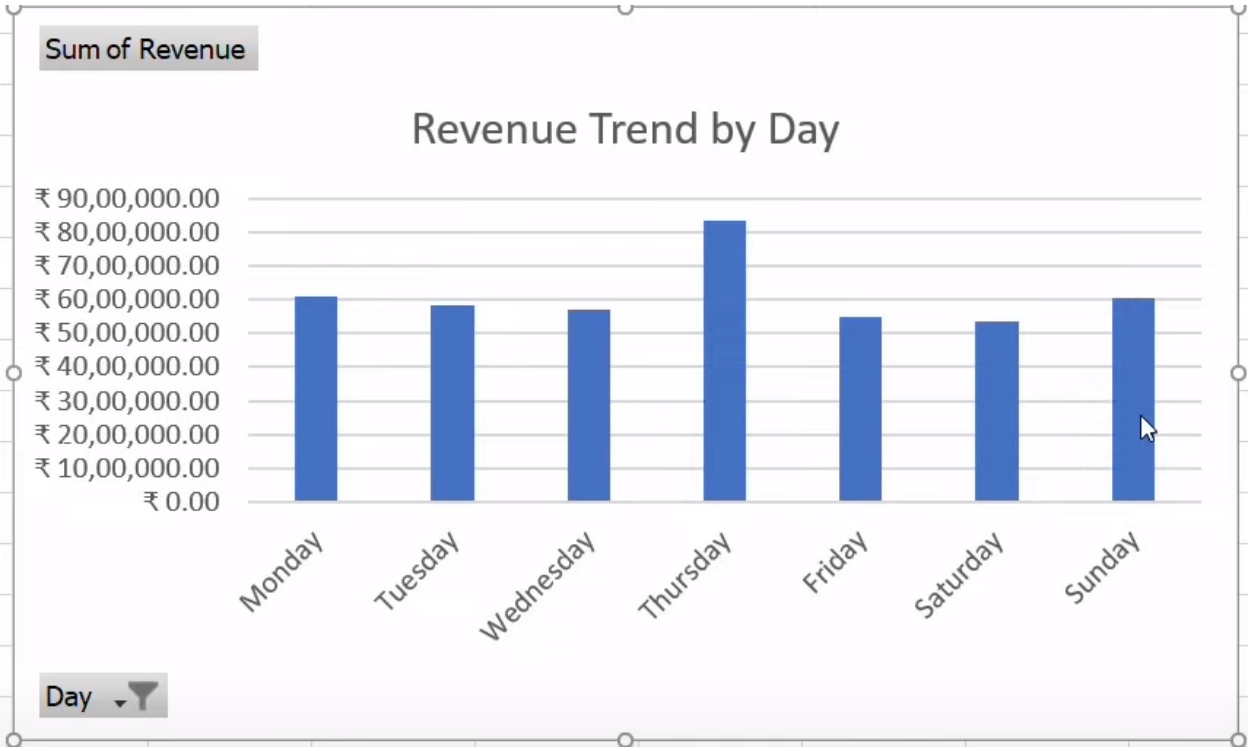
Then we insert a pivot table and pivot with respect to the day of the week, and show sum of volume.

3	Row Labels	Sum of Sale
4	Monday	975
5	Tuesday	1013
6	Wednesday	1002
7	Thursday	1458
8	Friday	984
9	Saturday	995
10	Sunday	1011
11	**Grand Total**	**7438**

We can see not much of a variation except on thursday, but this is because we have 3 thursdays in our data (15 days data) and every other day is measured only twice. This is not significant.



Similarly if we perform for the revenue weekly, we get:



We see that revenue is high on sundays and mondays as compared to other days.

Ledger and Average Days of Inventory

Tags	average days of inventory, days of sale, ledger, pivot tables, portfolio analysis, vlookup
Course	BDM
# Week	6
Created time	@August 28, 2023 1:31 PM

Comments from industry:

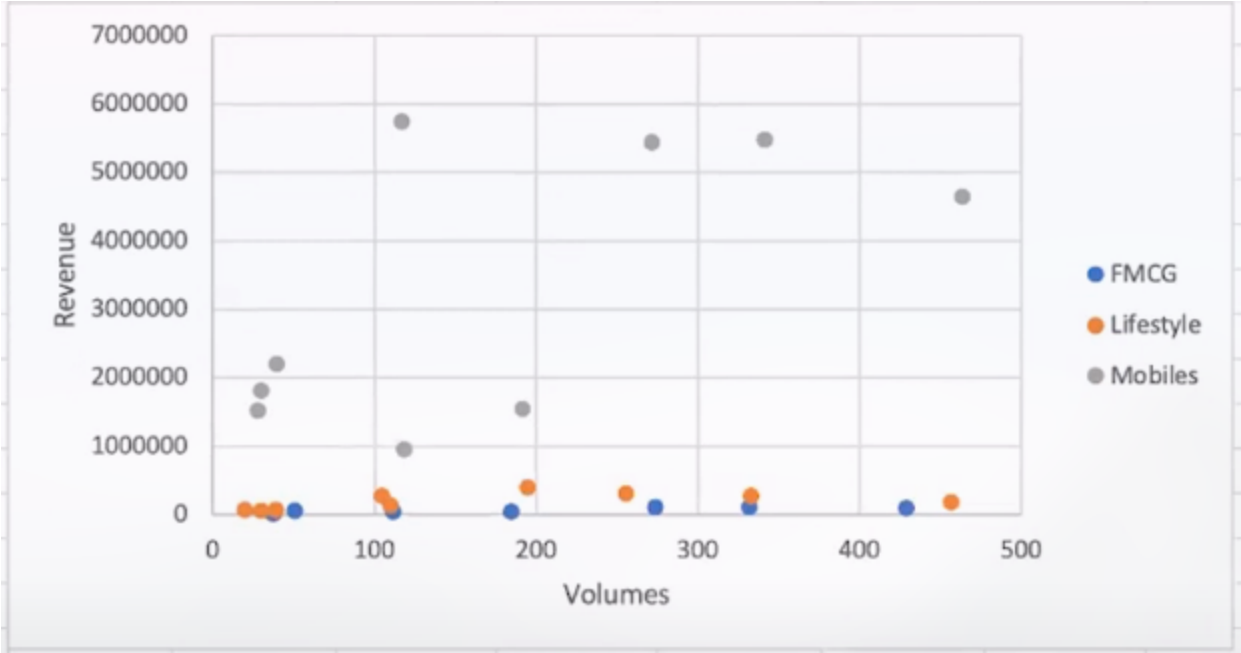
Pareto Analysis

- We can perform similar analysis on BU level
- We do not observe strong pareto on volume, but on revenue
- We discard mobiles from analysis usually as they skew the data a lot. We do BU level paretos for better insight.
- We do this on the scale of 1 million SKUs
- We give resources to each BU, but distribute that in pareto principle instead, so each BU has room to grow.
- We can directly sort and get percentages in the pivot table without copying the data.
- A movement in pareto is a very important insight and needs to be kept an eye on. It tells us how the market sentiment is changing and how we should adapt to it.

Portfolio Analysis

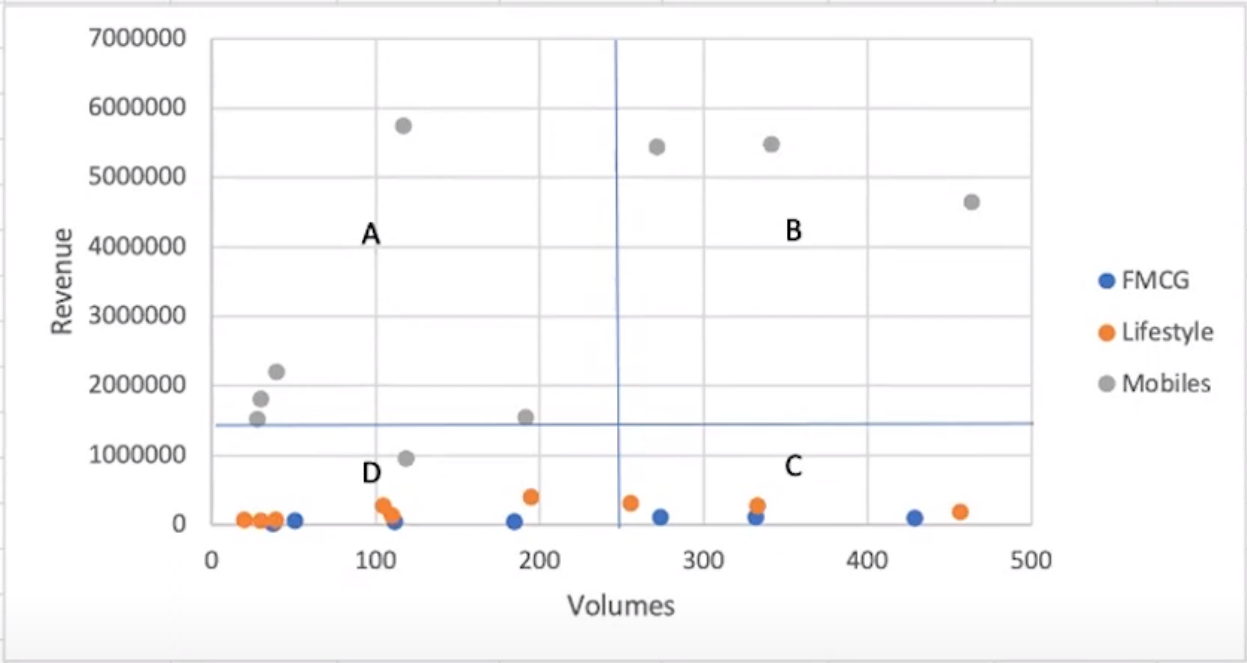
The pareto charts which we created last week gave us insights into revenue and volume individually, but not both together. For that we had plotted a scatter plot, but it was outweighed by the top performers of each BU.

If we remove the outliers from the data we get a more well-balanced graph:



We can also take logarithmic scale to evenly distribute the graph.

Now, we can divide the graph in 4 quadrants by dividing the volume into fast movers and slow movers, and revenue into high value and low value.



Thus, for

- Fast movers, we store them closer to the dock or processing area for speedy processing.
    - We can take example of our kitchen, we store spices used frequently close to the stove, and infrequent ingredients far away.
- High value items should be stored more securely, maybe with a lock and key or a secure bay.

Here security outweighs speed, so even items in top right corner (high speed high value items) will be put in secure area, even if thats far from processing bay.

Trend Analysis

- The thursday is outlier as we had three datapoints for it and two for rest
- Date-wise trend is not useful as number of data points is less, seasonal effects can be seen on a yearlong dataset
- Although no daily trend, we see a spike of orders in time data, everyday after 9pm the order increases. Also 4am there is a spike

- We prepare for Diwali / Big Billion Days (October) from around May itself as the volume is huge.
- Some special SKUs are only launched on offer days.
- The 4th April Sale caused a spike in revenue growth

Ledger and Average Days of Inventory

Let us find if the inventory of each SKU lasts or we go out of stock.

	A	B	C	D	E	F	G	H
1	SKU	F02						
2								
3	**Row Labels**	**Sum of Sale**	Cumulative Sales					
4	01-04-2021	26	26			Open Stock		272
5	02-04-2021	26	52					
6	03-04-2021	28	80					
7	04-04-2021	33	113					
8	05-04-2021	28	141					
9	06-04-2021	30	171					
10	07-04-2021	32	203					
11	08-04-2021	25	228					
12	09-04-2021	26	254					
13	10-04-2021	27	281					
14	11-04-2021	29	310					
15	12-04-2021	26	336					
16	13-04-2021	33	369					
17	14-04-2021	25	394					
18	15-04-2021	35	429					
19	**Grand Total**	**429**						

We see that the opening stock runs out after 10th April. This is done in total, not for separate DCs.

We can now take the average of the sales and divide the opening stock by it to get average days of inventory.

Days of sales availab =H4/B21

	Row Labels	Sum of Sale	Cumulative Sales		
4	01-04-2021	26	26	Open Stock	272
5	02-04-2021	26	52	Days of sales availabl	9.51049
6	03-04-2021	28	80		
7	04-04-2021	33	113		
8	05-04-2021	28	141		
9	06-04-2021	30	171		
10	07-04-2021	32	203		
11	08-04-2021	25	228		
12	09-04-2021	26	254		
13	10-04-2021	27	281		
14	11-04-2021	29	310		
15	12-04-2021	26	336		
16	13-04-2021	33	369		
17	14-04-2021	25	394		
18	15-04-2021	35	429		
19	Grand Total	429			
20					
21	Average daily s	28.6			

We can see for SKU M01, the days of sales available is very low.

1	SKU	M01			
2					
3	Row Labels	Sum of Sale	Cumulative Sales		
4	01-04-2021	57	57	Open Stock	220
5	02-04-2021	59	116	Days of sales availabl	3.63036

This is the reason why CFO asks about M01.

But this does not take into consideration the stock transfers from mother DC (H) to each child DC.

Lets now calculate actual stock at the end of each day by using the formula

$$\text{Closing Stock} = \text{Opening Stock} - \text{Sales} + \text{Transfer}$$

First we create a pivot table of sales of each SKU daily.

	City	M									
2											
3	Sum of Sale	Column Labels									
4	Row Labels	01-04-2021	02-04-2021	03-04-2021	04-04-2021	05-04-2021	06-04-2021	07-04-2021	08-04-2021	09-04-2021	10-04-2021	11
5	F01	14	9	13	6	21	18	2	24	5	13	
6	F02	13	5	4	2	7	3	7	3	1	3	
7	F03	8	5	7	0	0	6	5	0	4	1	
8	F04	1	1	3	2	1	7	2	7	6	6	
9	F05	2	0	0	4	3	7	4	2	0	3	
10	F06	0	3	0	2	1	1	2	0	3	1	
11	F07	4	1	1	0	1	3	4	2	1	3	
12	F08	1	0	0	0	0	0	1	0	2	0	
13	F09	0	1	0	1	0	0	0	0	1	0	
14	F10	0	0	0	0	1	1	0	0	0	2	
15	L01	20	18	17	18	18	20	25	22	19	24	
16	L02	8	10	11	9	14	10	10	10	8	11	
17	L03	8	7	7	9	7	7	6	9	7	7	
18	L04	4	4	6	6	5	6	7	6	6	5	
19	L05	3	1	4	2	3	2	5	1	4	5	

This is the sales data of each SKU of each day for city of madras.

We already have the sheet for the stock transfer for madras.

1	C													
2	06-Apr	07-Apr	08-Apr	09-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr	01-Apr	02-Apr	03-Apr	04-Apr
3	19	15	12	16	15	13	8	13	11	19	7	9	14	7
4	8	7	6	7	9	5	9	6	10	6	4	4	7	6
5	7	4	5	5	6	4	7	6	6	4	5	4	3	3
6	4	6	4	3	5	4	4	4	4	3	2	3	3	2
7	2	4	4	5	5	4	4	4	3	4	3	3	3	2
8	2	4	2	3	3	3	2	3	3	2	2	2	1	2
9	2	2	2	2	3	2	3	3	2	3	2	2	3	2
10	1	2	2	2	2	2	2	2	2	2	1	1	1	1
11	1	2	2	1	2	2	2	2	2	2	1	1	1	1
12	2	2	1	1	1	2	3	2	3	2	1	1	1	1
13	6	12	10	10	10	5	10	10	7	6	21	12	12	20
14	5	6	4	5	4	5	3	6	4	3	11	10	6	8
15	4	4	3	5	4	4	3	3	3	4	8	7	4	5
16	3	2	3	3	2	3	2	3	2	3	3	5	6	6
17	4	5	3	3	3	4	4	4	5	5	3	3	3	4
18	4	2	3	3	3	3	3	2	2	3	1	1	1	1
19	3	4	3	3	3	3	4	4	3	3	1	1	1	1
20	2	1	1	1	2	2	1	1	1	2	1	1	1	1

So we just take the data and add them accordingly.

E2 =D2+ vlookup($A2,'Stock Transfer'!$A:$ZZ,61+E$1,False)-vlookup($A2,'daily-sales'!$H:$AL,1+E$1,False)

	B	C	D	E	F	G	H	I	J	K	L	M
1	Description	Category	Nashik	1	2	3	4	5	6	7	8	9
2	Prateek England	Fashion	221	231	211	238	221	262	247	223	238	224
3	Lucy Phillepe	Fashion	101	126	138	154	179	213	244	262	279	285
4	Badlands	Fashion	98	120	125	137	167	197	224	233	251	274
5	Allen Dolly	Fashion	179	209	220	229	261	270	296	315	341	361
6	Bucchi	Fashion	92	124	108	121	137	159	199	193	229	237
7	Jhaomi	Mobiles	70	79	42	12	4	19	27	34	41	54
8	Samson	Mobiles	52	64	43	22	2	8	22	30	43	52
9	Mokia	Mobiles	57	64	43	18	-1	7	10	26	33	38
10	Hotorola	Mobiles	56	69	48	18	-3	10	19	37	48	55
11	2plus	Mobiles	58	77	44	18	19	37	55	77	81	98
12	Harry putar	Books	73	120	92	107	119	146	175	181	211	231
13	4 states	Books	65	73	97	104	110	119	162	199	203	203
14	Shaktiman Returns	Books	68	90	75	98	97	94	135	168	157	151
15	Goli's Travel	Books	70	61	60	54	45	82	114	124	118	127
16	Story of Your Life	Books	71	95	88	76	94	108	124	147	177	201
17	Prince of Dholakpur	Video Games	221	218	191	175	168	168	167	162	148	143
18	Nario	Video Games	146	142	125	100	81	88	80	65	67	74
19	Pacman	Video Games	156	160	135	117	92	76	77	80	81	88
20	LTA Wise City	Video Games	171	166	146	119	103	102	97	83	72	72
21	HIFA 2023	Video Games	227	211	179	159	140	145	139	123	107	103
22	Abibas Football	Sports / Fitness	56	69	76	34	20	32	52	50	51	57
23	Rural Terrain Cycles	Sports / Fitness	146	150	129	94	92	106	113	112	117	124
24	Monex Badminton Rackets	Sports / Fitness	63	67	36	8	0	8	29	38	54	48
25	Yoga Mattress	Sports / Fitness	56	50	44	9	11	13	43	53	43	60
26	Rocky Gym Set	Sports / Fitness	117	128	86	46	32	36	49	52	57	54
27	Pyllum Trimmers	Medicines/Health	65	75	38	12	0	7	21	28	38	60
28	Softcare Electric Toothbrush	Medicines/Health	64	84	75	59	44	54	69	76	76	76
29	Leg Messager	Medicines/Health	64	75	60	32	38	54	73	84	97	123
30	NoFat Weighing Scale	Medicines/Health	65	72	40	25	5	20	25	35	46	60
31	Screw Activity Watch	Medicines/Health	63	78	41	18	9	6	16	29	47	54
32	Surelt Purifier	Kitchen	65	77	81	58	39	72	74	83	66	101
33	Parrot Induction Stove	Kitchen	331	329	309	310	291	277	272	264	280	272
34	Jalepenoware Tiffin	Kitchen	131	146	146	114	92	80	101	77	88	95
35	Yamaka Rex 5000W Mixer Grinder	Kitchen	101	72	99	79	66	93	103	82	119	127
36	Mr.Clean Dishwasher	Kitchen	111	86	60	39	69	89	82	85	71	85
37	Blessing Atta 10kg pack	Household	237	227	261	289	318	336	367	386	419	445

Some places the closing stock is negative, this is because if number of sales is more than intransfer, then it goes directly from mother DC. so we have to take a max(x,0) to make a lower limit of 0.

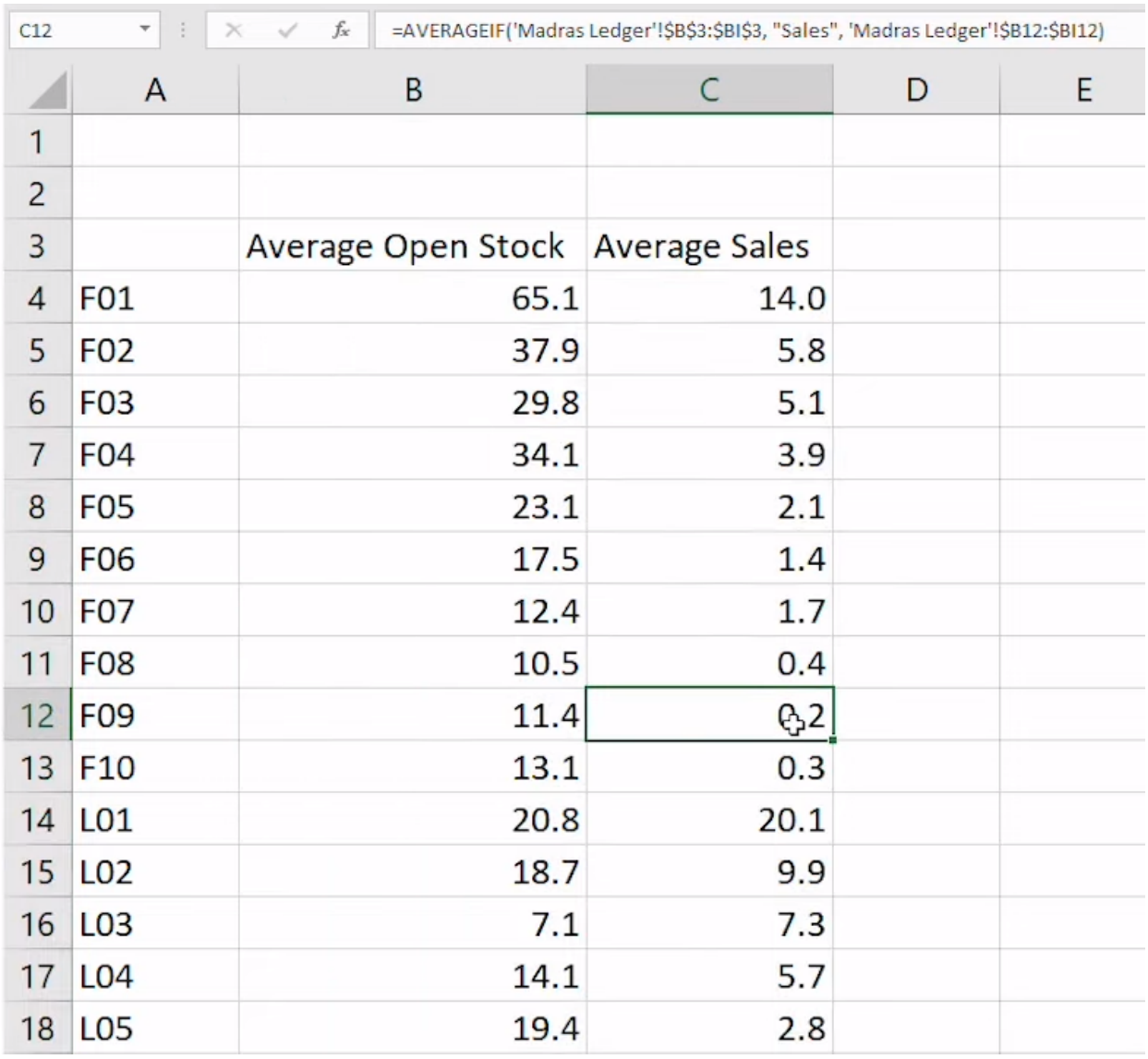
E2:AH51 =max(D2+ vlookup($A2,'Stock Transfer'!$A:$ZZ,61+E$1,False)-vlookup($A2,'daily-sales'!$H:$AL,1+E$1,False),0)

	A	B	C	D	E	F	G	H	I	J
1	SKU	Description	Category	Nashik	1	2	3	4	5	6
2	F001	Prateek England	Fashion	221	231	211	238	221	262	247
3	F002	Lucy Phillepe	Fashion	101	126	138	154	179	213	244
4	F003	Badlands	Fashion	98	120	125	137	167	197	224
5	F004	Allen Dolly	Fashion	179	209	220	229	261	270	296
6	F005	Bucchi	Fashion	92	124	108	121	137	159	199
7	M001	Jhaomi	Mobiles	70	79	42	12	4	19	27
8	M002	Samson	Mobiles	52	64	43	22	2	8	22
9	M003	Mokia	Mobiles	57	64	43	18	0	8	11
10	M004	Hotorola	Mobiles	56	69	48	18	0	13	22
11	M005	2plus	Mobiles	58	77	44	18	19	37	55
12	B001	Harry putar	Books	73	120	92	107	119	146	175
13	B002	4 states	Books	65	73	97	104	110	119	162
14	B003	Shaktiman Returns	Books	68	90	75	98	97	94	135
15	B004	Goli's Travel	Books	70	61	60	54	45	82	114
16	B005	Story of Your Life	Books	71	95	88	76	94	108	124
17	V001	Prince of Dholakpur	Video Games	221	218	191	175	168	168	167
18	V002	Nario	Video Games	146	142	125	100	81	88	80
19	V003	Pacman	Video Games	156	160	135	117	92	76	77
20	V004	LTA Wise City	Video Games	171	166	146	119	103	102	97
21	V005	HIFA 2023	Video Games	227	211	179	159	140	145	139
22	S001	Abibas Football	Sports / Fitness	56	69	76	34	20	32	52
23	S002	Rural Terrain Cycles	Sports / Fitness	146	150	129	94	92	106	113

(the last two images have different dataset (GA dataset) instead of lecture dataset because lecture was full of mistakes and this is done separately on another dataset to showcase the correct way to do it)

Average Days of Inventory

We can also take the average stock postion, and the average sales to calculate the average days of inventory



	A	B	C	D	E
1					
2					
3		Average Open Stock	Average Sales		
4	F01	65.1	14.0		
5	F02	37.9	5.8		
6	F03	29.8	5.1		
7	F04	34.1	3.9		
8	F05	23.1	2.1		
9	F06	17.5	1.4		
10	F07	12.4	1.7		
11	F08	10.5	0.4		
12	F09	11.4	0.2		
13	F10	13.1	0.3		
14	L01	20.8	20.1		
15	L02	18.7	9.9		
16	L03	7.1	7.3		
17	L04	14.1	5.7		
18	L05	19.4	2.8		

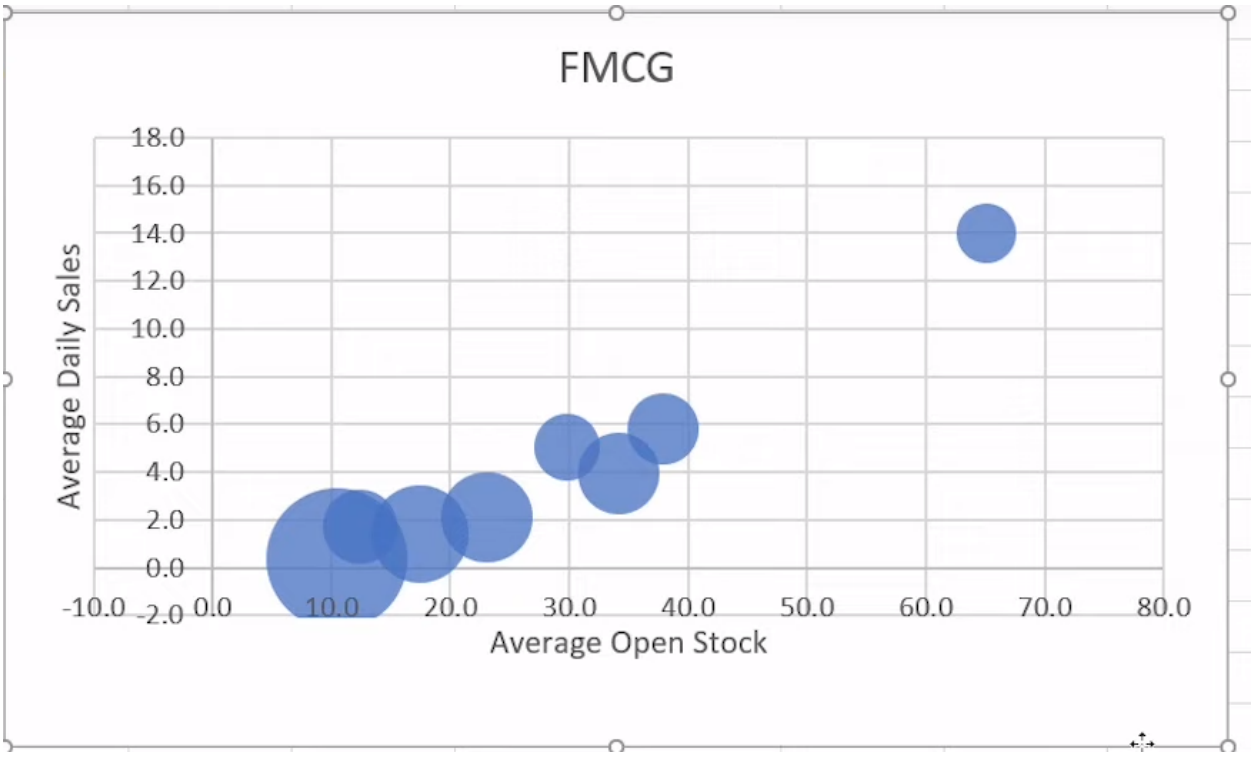
then we divide stock by sales to get days.

Average Open Stock	Average Sales	Average Days of Inventory
65.1	14.0	=B4/C4

Chart Area

		Average Open Stock	Average Sales	Average Days of Inventory
4	F01	65.1	14.0	4.6
5	F02	37.9	5.8	6.5
6	F03	29.8	5.1	5.9
7	F04	34.1	3.9	8.7
8	F05	23.1	2.1	10.8
9	F06	17.5	1.4	12.5
10	F07	12.4	1.7	7.2
11	F08	10.5	0.4	26.2
12	F09	11.4	0.2	57.0
13	F10	13.1	0.3	49.3
14	L01	20.8	20.1	1.0
15	L02	18.7	9.9	1.9
16	L03	7.1	7.3	1.0
17	L04	14.1	5.7	2.5
18	L05	19.4	2.8	6.9

and we can plot it into a bubble chart to visualise it.



Industry Reply:

- The M01 has short days of inventory because it is in short supply throughout India, as it is very highly demanded.
- The optimal days of inventory depends on the BU. for lifestyle and fashion we can afford to have higher DOI, but for perishables we want to have lower DOI.
- People tend to buy separate SKUs of clothing in same region to have unique outfit
- Clothes are usually designed in 2 (or 4) seasons in India (USA).
    - Spring-Summer and Autumn-Winter (Spring, Summer, Autumn, Winter in USA)
    - So clothes should be in inventory for entire season (180 days)
- We do not pay supplier directly when buying lifestyle products, we do **Sale on Return (SOR)**

> 💡 Goods sold on approval or return basis refers to **goods delivered to customers who have an option to retain or return them within a specified period**. (b) if the goods are not returned within specified period.

- If it is sold in the season, we pay for it, otherwise we return it to supplier and they replace it with new season item.

> 💡 Working capital is a financial metric which represents operating liquidity available to a business, organisation, or other entity, including governmental entities. Along with fixed assets such as plant and equipment, working capital is considered a part of operating capital.

$$\text{Working Capital} = \text{Current Assets} - \text{Current Liabilities}$$

- We invest working capital for electronics, but not apparel, there we invest the storage space.
- Some BUs are bought on credit and paid after a few days, so the retailer can use the money from the sale to pay off the supplier, this is called **negative working capital.**

> 💡 Negative Working Capital is **when a business' current liabilities exceed its current income and assets**. A temporarily Negative Working Capital typically occurs when a business makes a large purchase, such as investing in more stock, new products, or equipment.

Ledger for Madras

	A	B	C	D	E	F	G	H	I	J	K	L
1			1				2				3	
2		01/04/21				02/04/21				03/04/21		
3	SKU	Open Stock	Sales	Incoming	Closing Stock	Open Stock	Sales	Incoming	Closing Stock	Open Stock	Sales	Incoming
4	F01	50	14	7	43	43	9	9	43	43	13	14
5	F02	30	13	4	21	21	5	4	20	20	4	7
6	F03	18	8	5	15	15	5	4	14	14	7	3
7	F04	20	1	2	21	21	1	3	23	23	3	3
8	F05	13	2	3	14	14	0	3	17	17	0	3
9	F06	6	0	2	8	8	3	2	7	7	0	1
10	F07	10	4	2	8	8	1	2	9	9	1	3
11	F08	2	1	1	2	2	0	1	3	3	0	1
12	F09	2	0	1	3	3	1	1	3	3	0	1
13	F10	2	0	1	3	3	0	1	4	4	0	1
14	L01	74	20	21	75	75	18	12	69	69	17	12
15	L02	51	8	11	54	54	10	10	54	54	11	6
16	L03	28	8	8	28	28	7	7	28	28	7	4
17	L04	27	4	3	26	26	4	5	27	27	6	6
18	L05	13	3	3	13	13	1	3	15	15	4	3
19	L06	6	0	1	7	7	0	1	8	8	1	1
20	L07	3	0	1	4	4	1	1	4	4	0	1
21	L08	2	0	1	3	3	0	1	4	4	1	1
22	L09	1	0	0	1	1	0	0	1	1	0	0

Scatter_viz | Daily Revenues | Daywise Revenues | Days of Inventory | Madras_Sales | Madras_Average_inventory | Madras_Ledger | Sales Data | OPN STK | Open Stock Sorted

We have computed the opening stock for every day for madras DC on this the industry commented:

- If we have less than 7 days of stock anywhere, we raise an alarm and buy more of that stock

	A	B	C	D	E
3		Open Stock	Sales	Average Days of Inventory	
4	F01	34.2	14.0	2.44	
5	F02	24.1	5.8	4.16	
6	F03	19.9	5.1	3.93	
7	F04	19.6	3.9	4.98	
8	F05	12.8	2.1	6.00	
9	F06	8.4	1.4	6.00	
10	F07	10.5	1.7	6.08	
11	F08	6.5	0.4	16.17	
12	F09	7.0	0.2	35.00	
13	F10	7.1	0.3	26.50	
14	L01	53.2	20.1	2.65	
15	L02	42.1	9.9	4.24	
16	L03	16.7	7.3	2.29	
17	L04	21.9	5.7	3.87	
18	L05	14.5	2.8	5.19	
19	L06	10.4	1.2	8.67	
20	L07	6.5	0.5	12.25	
21	L08	7.2	0.3	21.60	
22	L09	2.4	0.1	36.00	
23	L10	6.7	0.3	25.00	
24	M01	15.7	21.1	0.74	

- we have low average days of inventory for fast moving items, and we are fine by it as we can have daily stock moving from mother to child DC
- average are not always correct tool, as it will hide data. here we wont know about stock outs
- if we have less than 2 days of stock of any SKU on any day, we ship more stock from mother to child
- items are broken down into **head-torso-tail.** where head are the high volume items, torso are in between, and tail are low volume items inside ONE BU. (another name of A/B/C analysis)

💡 **ABC Analysis:** In materials management, ABC analysis is an inventory categorisation technique. ABC analysis divides an inventory into three categories—"A items" with very tight control and accurate records, "B items" with less tightly controlled and good records, and "C items" with the simplest controls possible and minimal records.

- tail items (items very rarely bought) need to be stocked for people who want them, otherwise loss of business.
- There are some items in lifestyle BU which are never out of fashion (like white shirt), these should always be in stock and also close to the customer.

Notes

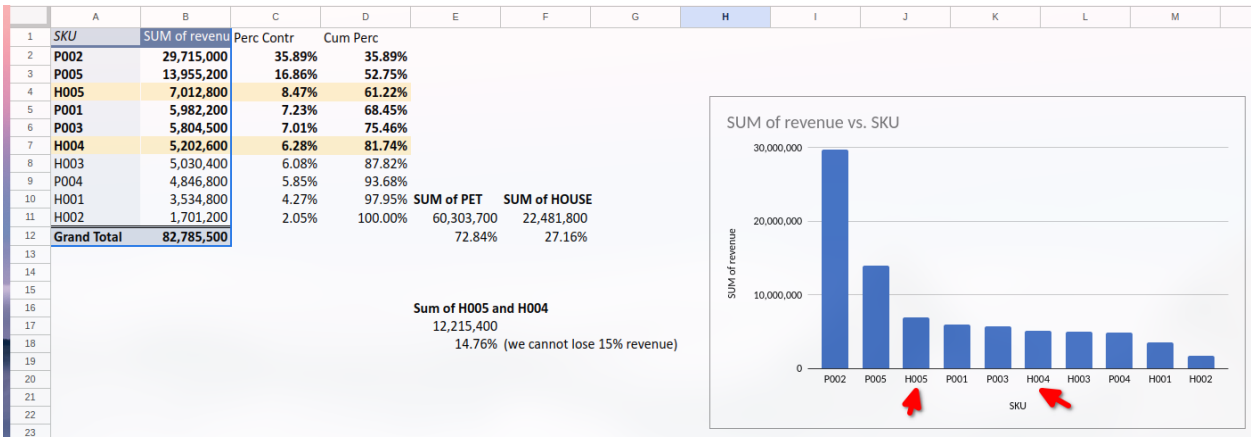
In the following question, we first need to find the sum of revenue of all the P and H SKUs individually, and then find the percentage contribution to the total.

8) When comparing the revenue generated by all Pet supplies and Groceries across all the DCs; Which one brings more money to the company? Should OG Commerce discontinue stocking and selling the other category? ***1 point***

- a.Pet Supplies; Yes discontinue selling groceries
- b.Groceries; Yes, discontinue selling Pet Supplies
- c.Pet Supplies; No, do not discontinue selling groceries
- d.Groceries; No, do not discontinue selling Pet Supplies

Accepted Answers:

c.Pet Supplies; No, do not discontinue selling groceries



SKU	SUM of revenu	Perc Contr	Cum Perc
P002	29,715,000	35.89%	35.89%
P005	13,955,200	16.86%	52.75%
H005	7,012,800	8.47%	61.22%
P001	5,982,200	7.23%	68.45%
P003	5,804,500	7.01%	75.46%
H004	5,202,600	6.28%	81.74%
H003	5,030,400	6.08%	87.82%
P004	4,846,800	5.85%	93.68%
H001	3,534,800	4.27%	97.95%
H002	1,701,200	2.05%	100.00%
Grand Total	82,785,500		

SUM of PET	SUM of HOUSE
60,303,700	22,481,800
72.84%	27.16%

Sum of H005 and H004
12,215,400
14.76% (we cannot lose 15% revenue)

- Sum of all P is > Sum of all H, thus Pet Supplies brings more money to the company than Household.
- The sum of all H is around 27% of the sum of (P+H), which is a lot, thus we cannot simply drop this BU. Moreover you can see the top $\frac{6}{10}$ (contributing to 80% of sales) contains two H SKUs which are 15% of the revenue, which is not insignificant at all.

Learning from FabMart Case Study

- Pareto (80% contribution by 20%)
  - Revenue
  - Volume
- Portfolio Analysis using Revenue vs Volume Scatter Plot
- Need for removal of outliers
- Ledger Analysis of a particular Location
- Looking at Daily Data as average may lose some insight
- Regularly monitoring parameters like DOH (Days on Hand) to ensure no stock-out
- Growth of business
- Managing Working Capital and Response Time to Customer (by stocking more or less of inventory)
- Diversity in products vs Focus Products (and ABC analysis)

- Different kinds of products have different kinds of expectations from the customer, phones are expected to have one day delivery, but clothes can take time.

Manufacturing Sector, Revenue Trend, Portfolio Management

Tags	ace gears, broaching, hobbing, manufacturing, portfolio management, revenue trend
Course	BDM
# Week	7
Created time	@August 28, 2023 6:30 PM

Manufacturing Sector (ACE Gears)

💡 Manufacturing is the creation or production of goods with the help of equipment, labor, machines, tools, and chemical or biological processing or formulation. It is the essence of the secondary sector of the economy. The term may refer to a range of human activity, from handicraft to high-tech, but it is most commonly applied to industrial design, in which raw materials from the primary sector are transformed into finished goods on a large scale. Such goods may be sold to other manufacturers for the production of other more complex products (such as aircraft, household appliances, furniture, sports equipment or automobiles), or distributed via the tertiary industry to end users and consumers (usually through wholesalers, who in turn sell to retailers, who then sell them to individual customers).

Examples of Manufacturing:

- Car
- Cookie

- Computer
- Mobile
- etc

It provides employement at very high scale.

India has presence in manufacturing in the core sectors like

- Oil and Gas
- Mining of Metals (Iron and Steel)
- Cement
- Fabrics (Cotton, Silk, Leather)
- Automobiles
- Food

Manufacturing sector also serves a B2B business model where they serve other companies who make something else for the customer from the output of the first company.

> 💡 Business-to-business, or B2B, refers to **commerce between two businesses rather than between a business and an individual consumer**. Transactions at the wholesale level are usually business-to-business, while those at the retail level are most often business-to-consumer (B2C)

This is also called **value chain.** The value of the end product is added one by one in chain, and all the steps and companies in between are important to have the end product.

> A car cannot exist if no company produces the engine, and no company can produce engines if no other company produces the gears.

In this analysis we will find:

- Sales and Revenue Analysis
- Production Planning and Analysis
- Profitability Analysis
- Raw Material Requirement Analysis
- Human Resources Requirement Analysis

What is ACE Gears?

Ace Gears is a **Tier-1 supplier** in the automotive industry. They manufacture and supply Gear Assemblies to OEMs and other Tier-1 suppliers.

> 💡 **Tier 1:** suppliers are **manufacturers that deal directly with OEM companies**. These are often major companies in their own right. You may recognize names like Bosch or BASF. Though Bosch is primarily a tier 1 supplier for the automotive industry, they're also well known for their own power tool product lines.

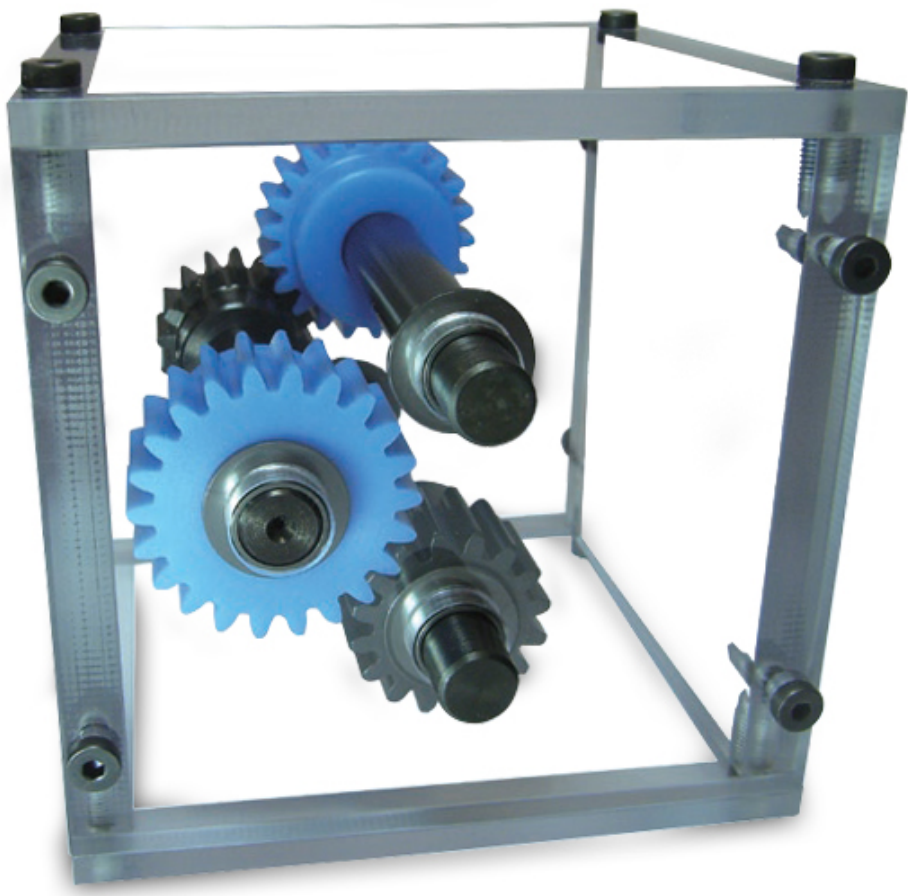
> 💡 **OEM:** stands for **original equipment manufacturer**. In the business world, this means a company that makes a product to be sold by another company under its own name.

They have customers in entire India. 10 of the numerous products of ACE Gears is considered in this case study.

> 💡 **Gear:** A gear is a rotating circular machine part having cut teeth or, in the case of a cogwheel or gearwheel, inserted teeth (called cogs), which mesh with another (compatible) toothed part to transmit (convert) torque and speed. The basic principle behind the operation of gears is analogous to the basic principle of levers.

Gears

> **Gear Assembly:** an assembly of parts, especially a train of gears, for transmitting and modifying motion and torque in a machine.



Gear Assembly

Challenges

- Automobile demand is highly varying, depending on government policies, festivals and season, economic state.
- Supply inconsistencies
- Labour shortage (COVID)
- GOI has forced stoppage of BS4, so ACE Gears will stop producing GA of BS4

The Products

Gear Type	Number of Assemblies
BS4 Engines Only	2
BS4 and BS6 Engines	6
BS6 Engines only	2

BS4 and BS6 are types of engines. Government of India has banned BS4 and only allows BS6 now, as BS4 produces more pollution. So two of the GA production will reduce, and two new GA will start as time goes on.

> One of the main BS4 and BS6 differences is the type of fuel these engines take. The sulphur concentration in BS4 fuel is 50ppm, which is reduced fivefold in BS6 fuel to 10ppm. Therefore, **BS6 fuel is comparatively cleaner than BS4**. It contains less sulphur and reduces harmful pollutants and emissions.

Emission Targets				
Engine Type	Mass of Exhaust Gas	BS4 Limit	BS6 Limit	Percentage Decrease
Petrol	CO (in mg/km)	1000	1000	Nil
	HC (in mg/km)	100	100	Nil
	Nox (in mg/km)	80	60	25
	PM (in mg/km)		4.5	
Diesel	CO (in mg/km)	500	500	Nil
	HC + NOx (in mg/km	300	170	43
	Nox (in mg/km)	250	80	68
	PM (in mg/km)	25	4.5	82

💡 **ERP System:** Enterprise resource planning is the integrated management of main business processes, often in real-time and mediated by software and technology.

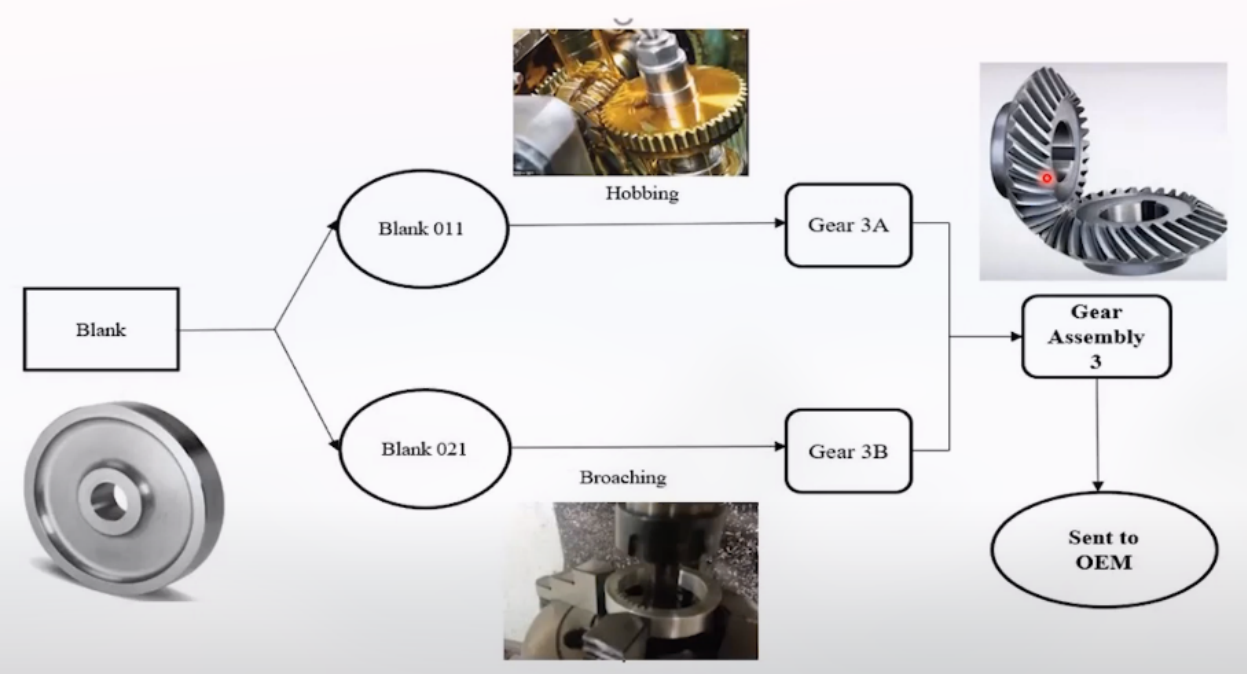
Companies are now using ERP systems to update all departments in one database.

Some data points are captured in paper first and then fed into the digital system.

Hobbing and Broaching

💡 Gear hobbing is **a quick and versatile process that is fundamental for gear manufacturing**. Gear hobbing machines utilize a rotating cutting tool, or hob, to generate a tooth profile on gears as they are fed through the machine. The precision and accuracy of gear hobbing makes it the ideal method for gear manufacturing. **It is the process of creating the outer teeth of gears.**

💡 Broaching is **ideal for cutting large gears or splines**. A broach is a sharp tool that is used to essentially carve the intended pattern into a piece of metal. The tool used can be customized based on the needed shape of the finished product. **It is used to create the shaft or inner teeths of gears.**



💡 **Financial Year:** What is Financial Year? The Financial Year can be simply defined as **a period of 12 months in which income is earned**. Any revenue generated between April 1, 2022, and March 31, 2023, will be assessed for the current Fiscal Year (FY) 2022-23 also shorted to FY23 (yes the ending year is used).

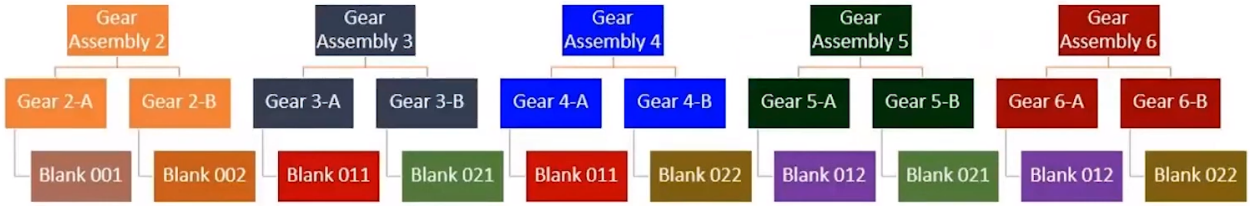
Production Plan

The production plan happens in hierarchical manner. First the overarching business goal is decided, then the year goal, then month goal, and then daily shifts and shift targets.

Similarly the Sales goal is decided first and then the material procurement, finally the production plan kicks in.

💡 Shifts are 8 hours long.

Blank - Gear - Gear Assembly Relationship:



💡 A gear blank is **a semi-finished component that's undergone all necessary processing, such as heat treatment and machining, except for the cutting of gear teeth**. It is a disc.

Dataset

Sales Details

	SALES DETAILS (GEAR ASSEMBLIES)							
		Apr-19		May-19		Jun-19		Jul-19
		Sales		Sales		Sales		Sales
		Quantity	Price	Quantity	Price	Quantity	Price	Quantity
5	Gear Assembly 1 (BS4)	8960 nos	420.00	7960 nos	420.00	10960 nos	420.00	5960 nos
6	Gear Assembly 2 (BS4)	7000 nos	375.00	6150 nos	375.00	10980 nos	375.00	6048 nos
7	Gear Assembly 3 (BS4/6)	6360 nos	535.00	11040 nos	535.00	960 nos	535.00	5160 nos
8	Gear Assembly 4 (BS4/6)	6960 nos	485.00	7748 nos	485.00	11475 nos	485.00	1664 nos
9	Gear Assembly 5 (BS4/6)	2880 nos	335.00	3955 nos	335.00	3555 nos	335.00	2929 nos
10	Gear Assembly 6 (BS4/6)	13700 nos	195.00	9000 nos	195.00	9100 nos	195.00	18900 nos
11	Gear Assembly 7 (BS4/6)	7152 nos	725.00	7708 nos	725.00	6606 nos	725.00	4230 nos
12	Gear Assembly 8 (BS4/6)	1920 nos	595.00	4560 nos	595.00	5040 nos	595.00	2400 nos
13	Gear Assembly 9 (BS6)	0 nos		0 nos		0 nos		0 nos
14	Gear Assmbly 10 (BS6)	0 nos		0 nos		0 nos		0 nos

This table shows the quantity and price of sale of each Gear Assembly for 24 months.

GA1 and GA2 eventually stop production in 2020 as BS6 is mandated and GA9 and GA10 productions kick in.

We can do the following analysis on this:

- The seasonal trend of volume and revenue
- The trend of BS4 vs BS6
- The GA which gives highest volume and revenue and lowest

Regional Sales Distribution

REGIONAL SALES DISTRIBUTION Q3-20	Oct 2019							N
	Overall	North	East	West	South	Overall	North	
Gear Assembly 1 (BS4)	14400 nos	0 nos	11200 nos	0 nos	3200 nos	13320 nos		
Gear Assembly 2 (BS4)	13824 nos	9865 nos	1125 nos		2834 nos	12048 nos	8150 nos	
Gear Assembly 3 (BS4/6)	2880 nos			2880 nos		6000 nos		
Gear Assembly 4 (BS4/6)	3600 nos	1755 nos		1845 nos		4440 nos	2560 nos	
Gear Assembly 5 (BS4/6)	2080 nos		2080 nos			1920 nos		
Gear Assembly 6 (BS4/6)	10040 nos	3350 nos	1780 nos	1260 nos	3650 nos	15659 nos	4750 nos	
Gear Assembly 7 (BS4/6)	5634 nos	1260 nos	950 nos		3424 nos	5124 nos	1185 nos	
Gear Assembly 8 (BS4/6)	1200 nos				1200 nos	2160 nos		

This table shows us the distribution of sales of 3 months (Q3 of FY20) into regions of India (North, East, West, South). In this table we can analyze:

- Which region brings in the maxium volume or revenue
- Which region has lowest variance in output
- Are some products and regions clustered

Production Plan of Gear Assemblies

PRODUCTION PLAN - FINAL ASSEMBLY PROCESS INVOLVING ASSEMBLY OF TWO GEARS (DRIVE & DRIVEN)									
PRODUCTION & FG INVENTORY DETAILS									
	Apr-19	Apr-19		May-19		Jun-19		Jul-19	
		Production		Production		Production		Production	
	Beg. Invt.	Prod. Qty.	End Invt.	Quantity	End Invt.	Quantity	End Invt.	Quantity	En
Gear Assembly 1	3210 nos	7000 nos	1250 nos	9000 nos	2290 nos	9000 nos	330 nos	9000 nos	
Gear Assembly 2	2320 nos	6000 nos	1320 nos	6000 nos	1170 nos	10000 nos	190 nos	7500 nos	
Gear Assembly 3	1560 nos	8000 nos	3200 nos	8000 nos	160 nos	2000 nos	1200 nos	5000 nos	
Gear Assembly 4	3410 nos	6000 nos	2450 nos	8000 nos	2702 nos	10000 nos	1227 nos	2000 nos	
Gear Assembly 5	970 nos	3000 nos	1090 nos	4000 nos	1135 nos	4000 nos	1580 nos	3000 nos	
Gear Assembly 6	5600 nos	12000 nos	3900 nos	12000 nos	6900 nos	12000 nos	9800 nos	12000 nos	
Gear Assembly 7	2460 nos	7000 nos	2308 nos	7000 nos	1600 nos	6000 nos	994 nos	6000 nos	
Gear Assembly 8	860 nos	3000 nos	1940 nos	4000 nos	1380 nos	4000 nos	340 nos	3000 nos	
Gear Assembly 9		0 nos	0 nos	0 nos	0 nos	0 nos	0 nos	0 nos	
Gear Assmbly 10		0 nos	0 nos	0 nos	0 nos	0 nos	0 nos	0 nos	

This table shows the production plan of each month keeping in mind the opening quantity of the month and the total inventory at end of month and the sales on that month.

$$\text{Closing Inventory} = \text{Opening Inventory} - \text{Sales} + \text{Production}$$

Production should not be as variable as sales, as its harder to change production rate, so we should predict future sales and inventory deficit and produce accordingly.

- How big of inventory space should I reserve based on predicted inventory size

Production Plan of Gears

47	GEAR PRODUCTION & INVENTORY (FOR GEAR ASSEMBLIES 2-6 ONLY)								
48									
49		Apr-19	Apr-19		May-19		Jun-19		Jul-19
50			Production		Production		Production		Production
51		Beg. Invt.	Prod. Qty.	End Invt.	Quantity	End Invt.	Quantity	End Invt.	Quantity
52	Gear 2-A	3350	5700	2750 nos	6250	2700 nos	9850	2050 nos	7890
53	Gear 2-B	3180	5810	2690 nos	6340	2730 nos	9670	1900 nos	7750
54	Gear 3-A	2105	7450	1155 nos	8250	1005 nos	4150	3055 nos	3250
55	Gear 3-B	2225	8250	2075 nos	8050	1725 nos	3820	3445 nos	2960
56	Gear 4-A	3810	3260	830 nos	8810	1320 nos	9540	460 nos	4100
57	Gear 4-B	4210	3460	1430 nos	7240	350 nos	11560	1510 nos	1560
58	Gear 5-A	1560	2050	310 nos	4560	470 nos	4340	410 nos	3310
59	Gear 5-B	1330	2560	590 nos	4480	670 nos	4150	420 nos	3595
60	Gear 6-A	4460	9450	1110 nos	12560	870 nos	12360	430 nos	12950
61	Gear 6-B	6510	8010	1720 nos	13010	1930 nos	11980	1110 nos	13560

This table, similar to the previous table, shows the production plan of gears for GA2-6

Blank-Gear Relation

4	GEAR MANUFACTURE FROM FORGED GEAR BLANKS - BILL OF MATERIAL	
5		
6	GEAR	MATCHING BLANK PART NUMBER
7	Gear 2-A	Blank-001
8	Gear 2-B	Blank-002
9	Gear 3-A	Blank-011
10	Gear 3-B	Blank-021
11	Gear 4-A	Blank-011
12	Gear 4-B	Blank-022
13	Gear 5-A	Blank-012
14	Gear 5-B	Blank-021
15	Gear 6-A	Blank-012
16	Gear 6-B	Blank-022

This table shows which Gear requires which Blank to be produced. As some blanks are common, irregularities in production may sometimes cancel out the irregularity in actual requirement of blanks.

Things to Analyze

- Revenue pattern of each GA
- Month-wise or Quarter-wise Revenue and Volume distribution for two years

    - Find trends in the distribution
    - Find for each GA
    - Which Month or Quarter makes the maximum revenue in each Financial Year
- Star Seller and Poor Seller GA in terms of revenue

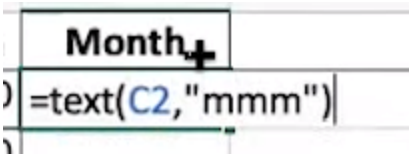
Analysis

We reformat the first table into a more processable format.

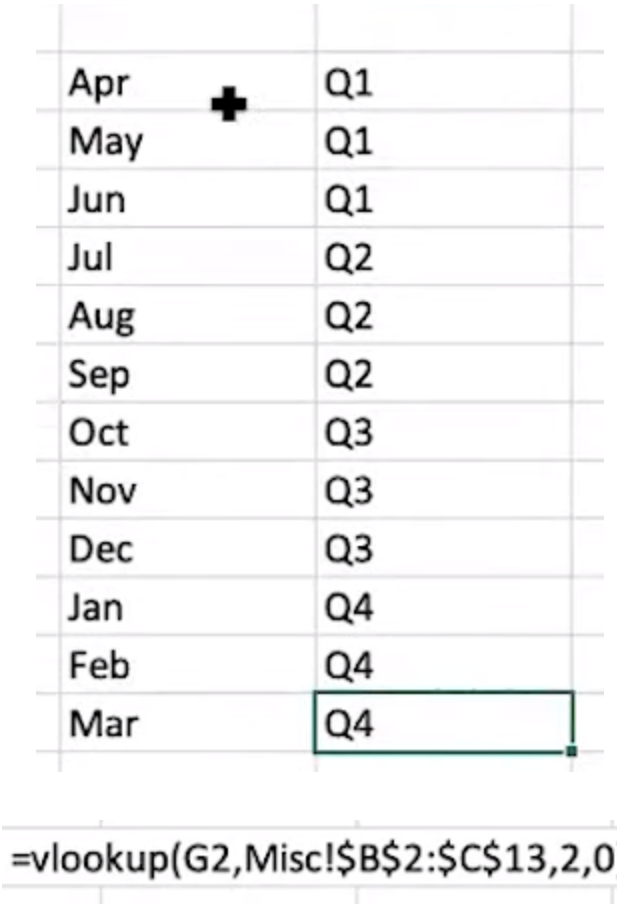
	A	B	C	D	E	F
1	**Gear Assembly**	**GA Category**	**Month**	**Quantity**	**Price**	**Production**
2	Gear Assembly 1 (BS4)	BS4	Apr-19	8960 nos	*420.00*	7000
3	Gear Assembly 2 (BS4)	BS4	Apr-19	7000 nos	*375.00*	6000
4	Gear Assembly 3 (BS4/6)	BS4/BS6	Apr-19	6360 nos	*535.00*	8000
5	Gear Assembly 4 (BS4/6)	BS4/BS6	Apr-19	6960 nos	*485.00*	6000
6	Gear Assembly 5 (BS4/6)	BS4/BS6	Apr-19	2880 nos	*335.00*	3000
7	Gear Assembly 6 (BS4/6)	BS4/BS6	Apr-19	13700 nos	*195.00*	12000
8	Gear Assembly 7 (BS4/6)	BS4/BS6	Apr-19	7152 nos	*725.00*	7000
9	Gear Assembly 8 (BS4/6)	BS4/BS6	Apr-19	1920 nos	*595.00*	3000
10	Gear Assembly 9 (BS6)	BS6	Apr-19	0 nos		0
11	Gear Assmbly 10 (BS6)	BS6	Apr-19	0 nos		0
12	Gear Assembly 1 (BS4)	BS4	May-19	*7960 nos*	420.00	9000
13	Gear Assembly 2 (BS4)	BS4	May-19	*6150 nos*	375.00	*6000*
14	Gear Assembly 3 (BS4/6)	BS4/BS6	May-19	*11040 nos*	535.00	*8000*
15	Gear Assembly 4 (BS4/6)	BS4/BS6	May-19	*7748 nos*	485.00	*8000*
16	Gear Assembly 5 (BS4/6)	BS4/BS6	May-19	*3955 nos*	335.00	*4000*
17	Gear Assembly 6 (BS4/6)	BS4/BS6	May-19	*9000 nos*	195.00	*12000*
18	Gear Assembly 7 (BS4/6)	BS4/BS6	May-19	*7708 nos*	725.00	*7000*
19	Gear Assembly 8 (BS4/6)	BS4/BS6	May-19	*4560 nos*	595.00	*4000*
20	Gear Assembly 9 (BS6)	BS6	May-19	*0 nos*		*0*
21	Gear Assmbly 10 (BS6)	BS6	May-19	*0 nos*		*0*
22	Gear Assembly 1 (BS4)	BS4	Jun-19	10960 nos	*420.00*	9000

the column D is not unsanitary, that is only the formatting. The values of colD are still numeric. We can change formatting and make it a regular numeric formatting.

- We extract the month from the timestamp



- We calculate which Quarter the month belongs to, using an auxiliary sheet and VLOOKUP

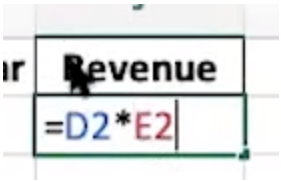


- finally we compute the fiscal year of the date using the same technique as previous

E	F
Month	Fiscal Year
Apr-19	FY19-20
May-19	FY19-20
Jun-19	FY19-20
Jul-19	FY19-20
Aug-19	FY19-20
Sep-19	FY19-20
Oct-19	FY19-20
Nov-19	FY19-20
Dec-19	FY19-20
Jan-20	FY19-20
Feb-20	FY19-20
Mar-20	FY19-20
Apr-20	FY20-21

```
=vlookup(C2,Misc!$E$2:$F$25,2,0)
```

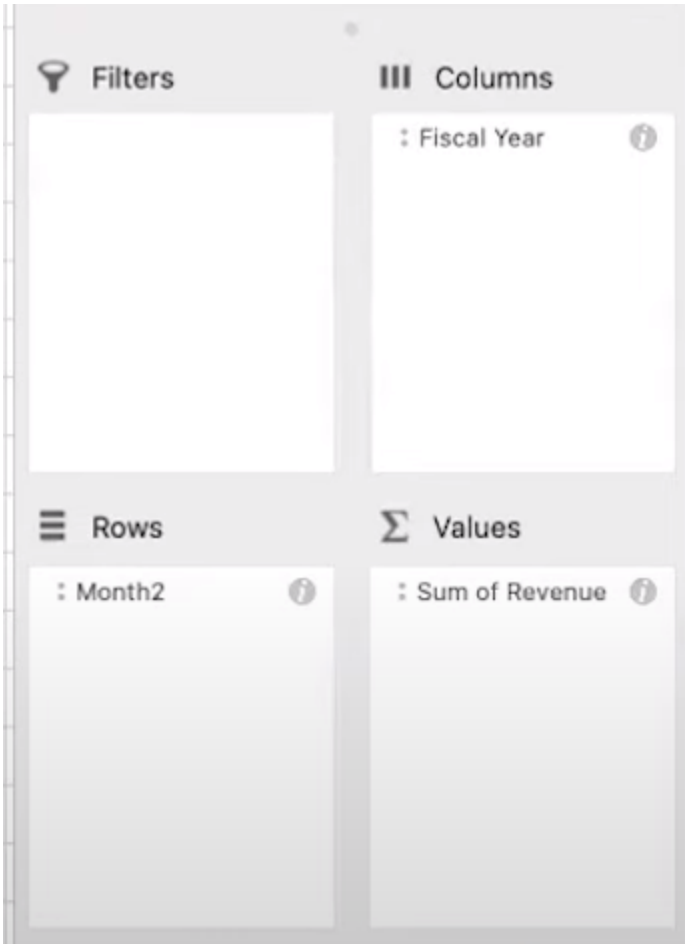
- compute the revenue as $\mathrm{Revenue} = \mathrm{Quantity} \times \mathrm{Price}$



so we get the following Data sheet

	A	B	C	D	E	F	G	H	I	J
1	Gear Assembly	GA Category	Month	Sales	Price	Production	Month	Quarter	Fiscal Year	Revenue
2	Gear Assembly 1 (BS4)	BS4	Apr-19	8960	420.00	7000	Apr	Q1	FY19-2	₹37,63,200
3	Gear Assembly 2 (BS4)	BS4	Apr-19	7000	375.00	6000	Apr	Q1	FY19-20	₹26,25,000
4	Gear Assembly 3 (BS4/6)	BS4/BS6	Apr-19	6360	535.00	8000	Apr	Q1	FY19-20	₹34,02,600
5	Gear Assembly 4 (BS4/6)	BS4/BS6	Apr-19	6960	485.00	6000	Apr	Q1	FY19-20	₹33,75,600
6	Gear Assembly 5 (BS4/6)	BS4/BS6	Apr-19	2880	335.00	3000	Apr	Q1	FY19-20	₹9,64,800
7	Gear Assembly 6 (BS4/6)	BS4/BS6	Apr-19	13700	195.00	12000	Apr	Q1	FY19-20	₹26,71,500
8	Gear Assembly 7 (BS4/6)	BS4/BS6	Apr-19	7152	725.00	7000	Apr	Q1	FY19-20	₹51,85,200
9	Gear Assembly 8 (BS4/6)	BS4/BS6	Apr-19	1920	595.00	3000	Apr	Q1	FY19-20	₹11,42,400
10	Gear Assembly 9 (BS6)	BS6	Apr-19	0		0	Apr	Q1	FY19-20	₹0
11	Gear Assmbly 10 (BS6)	BS6	Apr-19	0		0	Apr	Q1	FY19-20	₹0
12	Gear Assembly 1 (BS4)	BS4	May-19	7960	420.00	9000	May	Q1	FY19-20	₹33,43,200
13	Gear Assembly 2 (BS4)	BS4	May-19	6150	375.00	6000	May	Q1	FY19-20	₹23,06,250
14	Gear Assembly 3 (BS4/6)	BS4/BS6	May-19	11040	535.00	8000	May	Q1	FY19-20	₹59,06,400
15	Gear Assembly 4 (BS4/6)	BS4/BS6	May-19	7748	485.00	8000	May	Q1	FY19-20	₹37,57,780
16	Gear Assembly 5 (BS4/6)	BS4/BS6	May-19	3955	335.00	4000	May	Q1	FY19-20	₹13,24,925
17	Gear Assembly 6 (BS4/6)	BS4/BS6	May-19	9000	195.00	12000	May	Q1	FY19-20	₹17,55,000
18	Gear Assembly 7 (BS4/6)	BS4/BS6	May-19	7708	725.00	7000	May	Q1	FY19-20	₹55,88,300
19	Gear Assembly 8 (BS4/6)	BS4/BS6	May-19	4560	595.00	4000	May	Q1	FY19-20	₹27,13,200
20	Gear Assembly 9 (BS6)	BS6	May-19	0		0	May	Q1	FY19-20	₹0
21	Gear Assmbly 10 (BS6)	BS6	May-19	0		0	May	Q1	FY19-20	₹0
22	Gear Assembly 1 (BS4)	BS4	Jun-19	10960	420.00	9000	Jun	Q1	FY19-20	₹46,03,200

So now we can create PIVOT TABLEs to analyze the requirements.



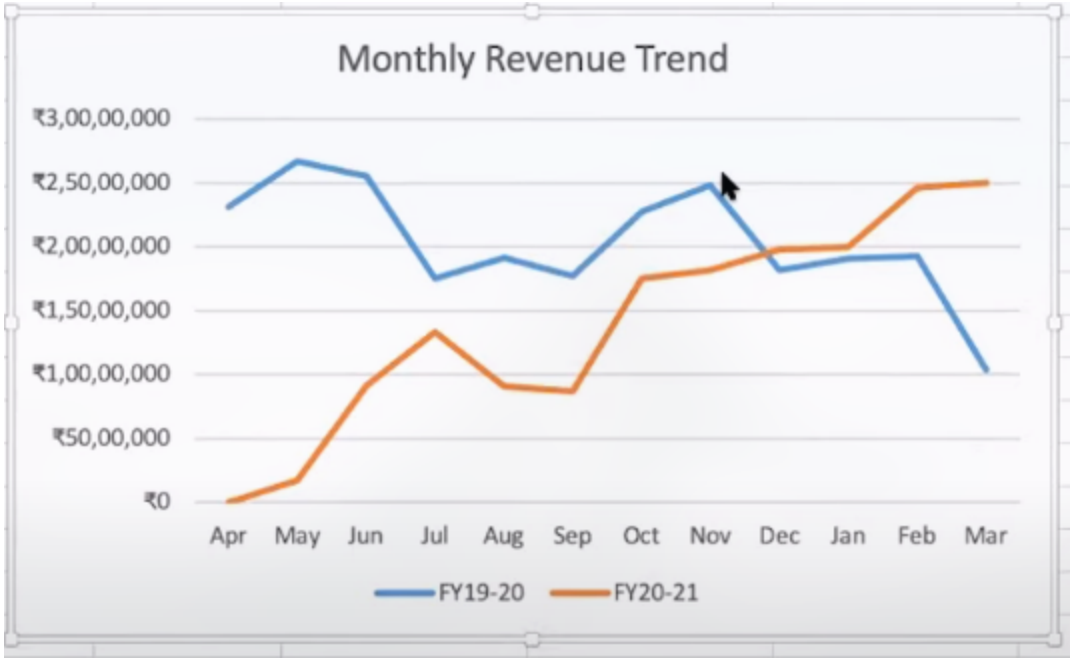
Monthly Revenue Analysis

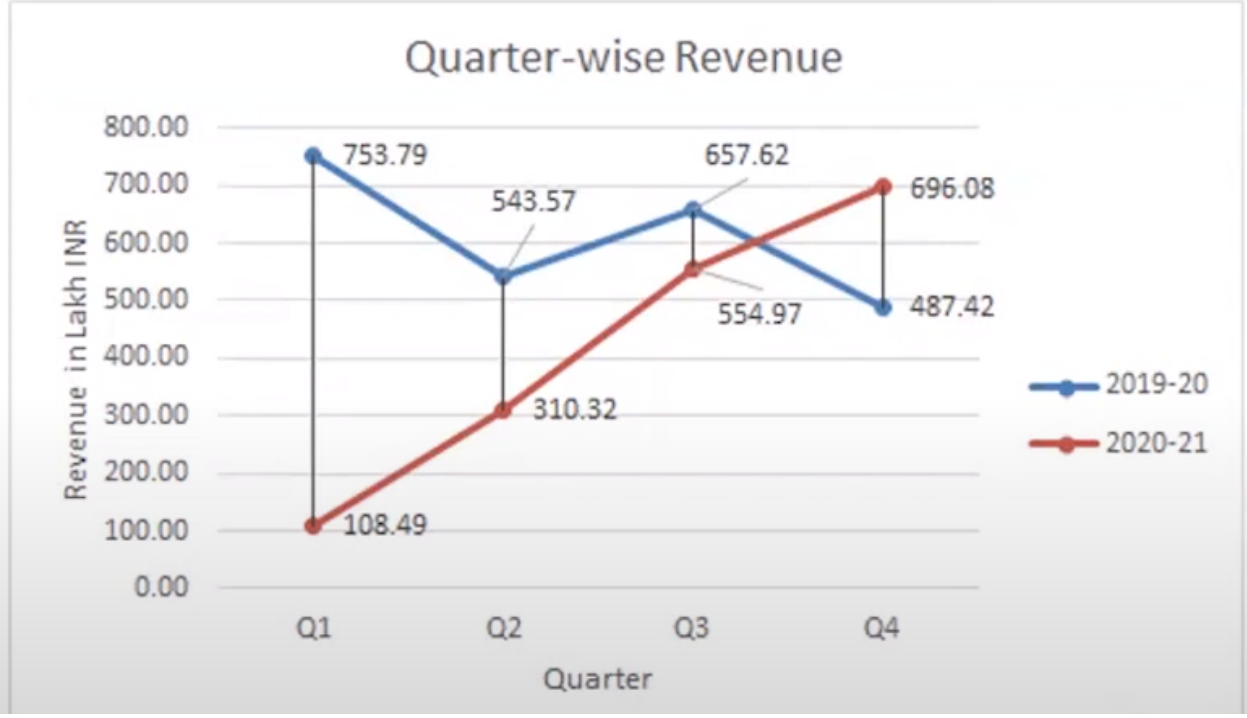
3	Sum of Revenue	Column Labels		
4	Row Labels	FY19-20	FY20-21	Grand Total
5	Jan	19072415	19991900	39064315
6	Feb	19281985	24597550	43879535
7	Mar	10387780	25018810	35406590
8	Apr	23130300	0	23130300
9	May	26695055	1684805	28379860
10	Jun	25553250	9163905	34717155
11	Jul	17500305	13313890	30814195
12	Aug	19148750	9048915	28197665
13	Sep	17708325	8668910	26377235
14	Oct	22737890	17540645	40278535
15	Nov	24846405	18143250	42989655
16	Dec	18177410	19813475	37990885
17	**Grand Total**	**244239870**	**166986055**	**411225925**

We can then re-order it from April to March

Row Labels	FY19-20	FY20-21	Grand Total
Apr	₹2,31,30,300	₹0	₹2,31,30,300
May	₹2,66,95,055	₹16,84,805	₹2,83,79,860
Jun	₹2,55,53,250	₹91,63,905	₹3,47,17,155
Jul	₹1,75,00,305	₹1,33,13,890	₹3,08,14,195
Aug	₹1,91,48,750	₹90,48,915	₹2,81,97,665
Sep	₹1,77,08,325	₹86,68,910	₹2,63,77,235
Oct	₹2,27,37,890	₹1,75,40,645	₹4,02,78,535
Nov	₹2,48,46,405	₹1,81,43,250	₹4,29,89,655
Dec	₹1,81,77,410	₹1,98,13,475	₹3,79,90,885
Jan	₹1,90,72,415	₹1,99,91,900	₹3,90,64,315
Feb	₹1,92,81,985	₹2,45,97,550	₹4,38,79,535
Mar	₹1,03,87,780	₹2,50,18,810	₹3,54,06,590
Grand Total	₹24,42,39,870	₹16,69,86,055	₹41,12,25,925

and finally we can draw a line graph to visualize the trend.





Now it is abundantly clear how the lockdown affected the production.

Monthly Analysis: (in lakhs of INR)

Month-On-Month:

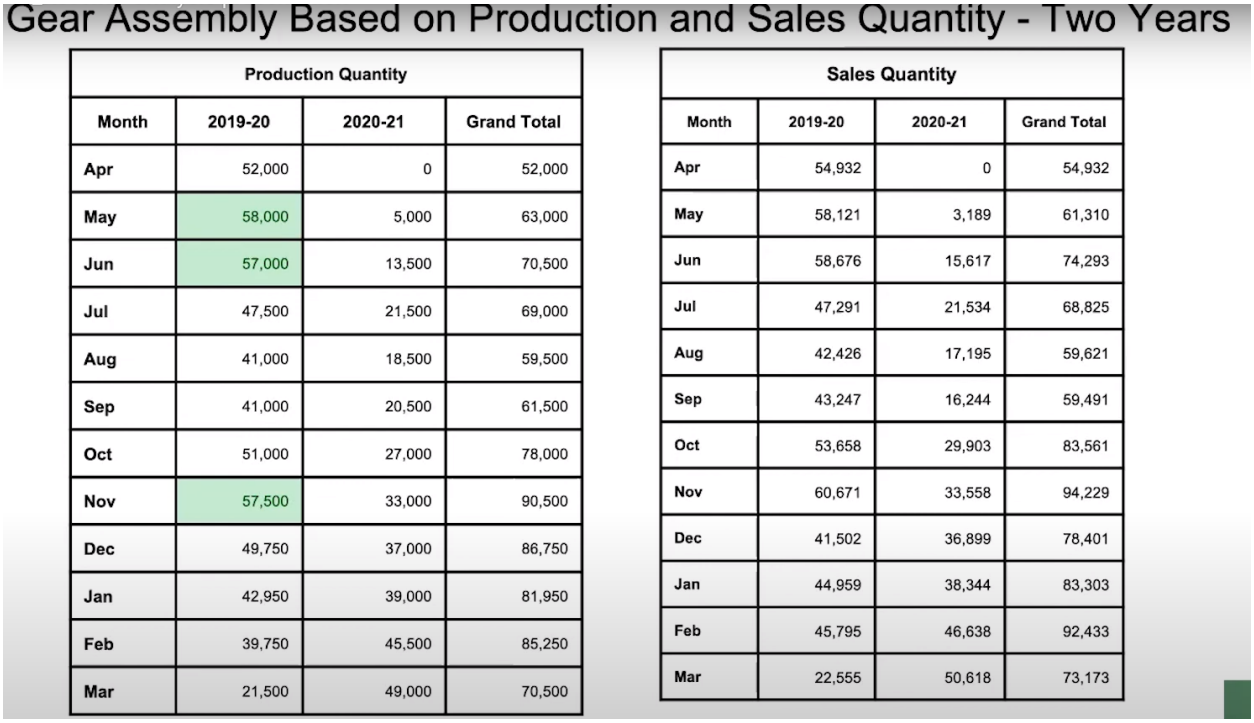
Month	2019-20	2020-21	% Change	2019-21
Apr	231.30	0	-100.00%	231.30
May	266.95	16.85	-93.69%	283.80
Jun	255.53	91.64	-64.14%	347.17
Jul	175.00	133.14	-23.92%	308.14
Aug	191.49	90.49	-52.74%	281.98
Sep	177.08	86.67	-51.05%	263.77
Oct	227.38	175.41	-22.86%	402.79
Nov	248.46	181.43	-26.98%	429.90
Dec	181.77	198.13	9.00%	379.91
Jan	190.72	199.92	4.82%	390.64
Feb	192.82	245.98	27.57%	438.80
Mar	103.88	250.19	140.85%	354.07
Total	**2,442.39**	**1,669.86**	**-31.63%**	**4,112.26**

Quarter-on-Quarter:

Quarter	2019-20	2020-21	% Change	Grand Total
Q1	753.79	108.49	-85.61%	862.27
Q2	543.57	310.32	-42.91%	853.89
Q3	657.62	554.97	-15.61%	1212.59
Q4	487.42	696.08	42.81%	1183.50
Grand Total	**2,442.40**	**1,669.86**	**-31.63%**	**4,112.26**

Companies are usually comparing FY21-22 to FY19-20 instead of the preceding FY20-21 as that was abnormal due to COVID.

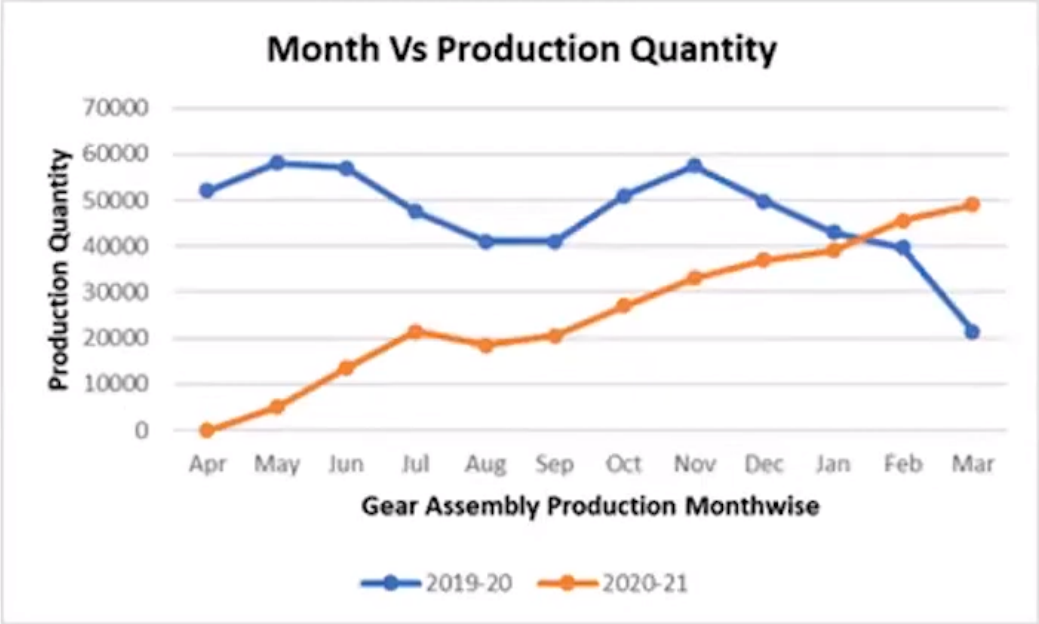
Sales and Production Volume

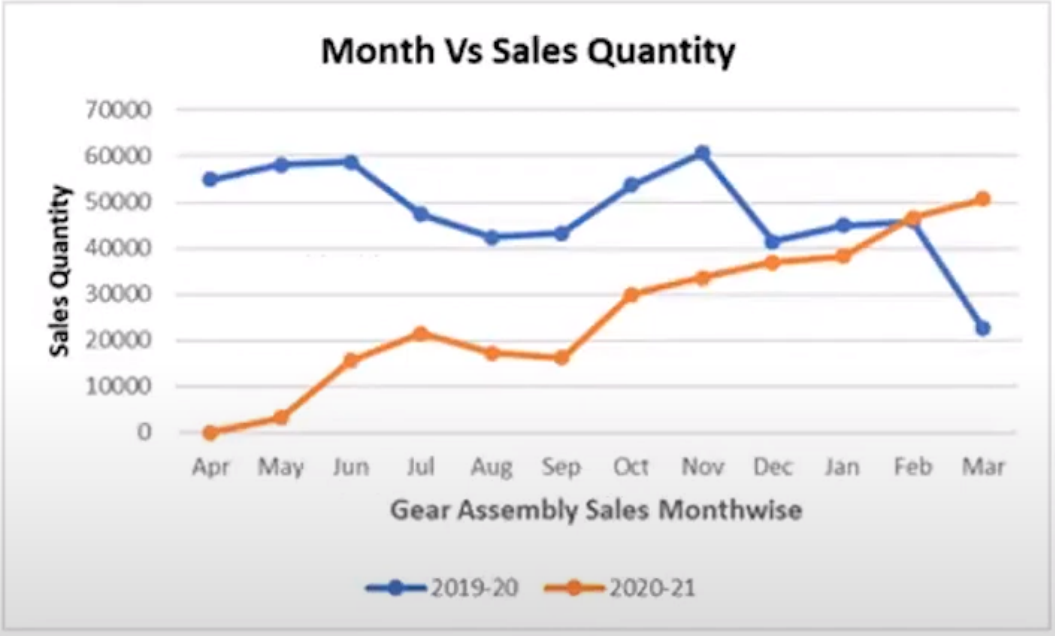


Gear Assembly Based on Production and Sales Quantity - Two Years

Production Quantity			
Month	2019-20	2020-21	Grand Total
Apr	52,000	0	52,000
May	58,000	5,000	63,000
Jun	57,000	13,500	70,500
Jul	47,500	21,500	69,000
Aug	41,000	18,500	59,500
Sep	41,000	20,500	61,500
Oct	51,000	27,000	78,000
Nov	57,500	33,000	90,500
Dec	49,750	37,000	86,750
Jan	42,950	39,000	81,950
Feb	39,750	45,500	85,250
Mar	21,500	49,000	70,500

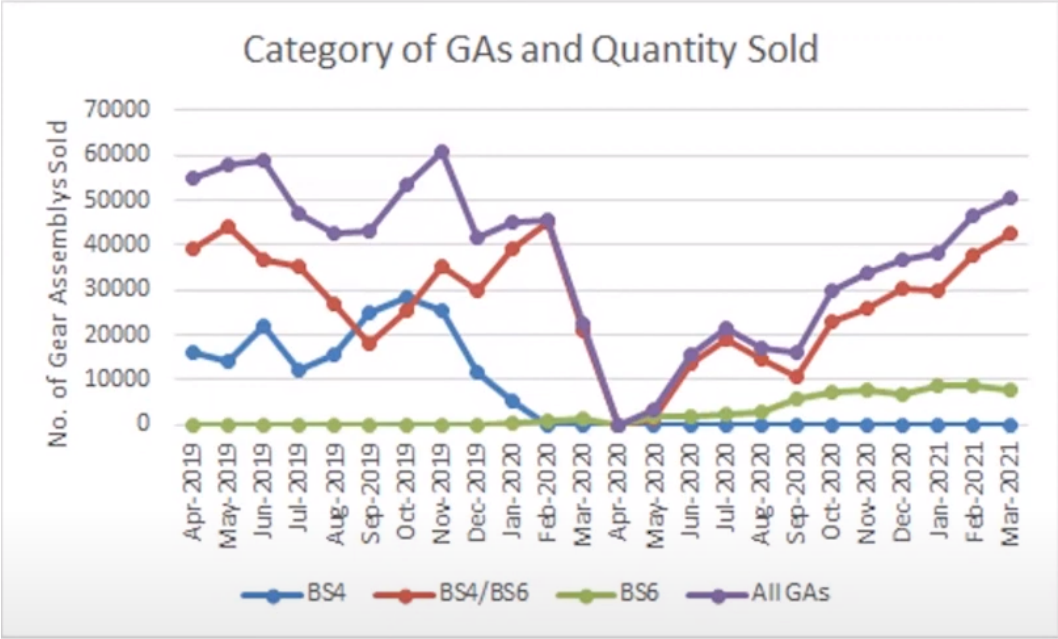
Sales Quantity			
Month	2019-20	2020-21	Grand Total
Apr	54,932	0	54,932
May	58,121	3,189	61,310
Jun	58,676	15,617	74,293
Jul	47,291	21,534	68,825
Aug	42,426	17,195	59,621
Sep	43,247	16,244	59,491
Oct	53,658	29,903	83,561
Nov	60,671	33,558	94,229
Dec	41,502	36,899	78,401
Jan	44,959	38,344	83,303
Feb	45,795	46,638	92,433
Mar	22,555	50,618	73,173





- Production follows trend of Sales, but in a smoother curve

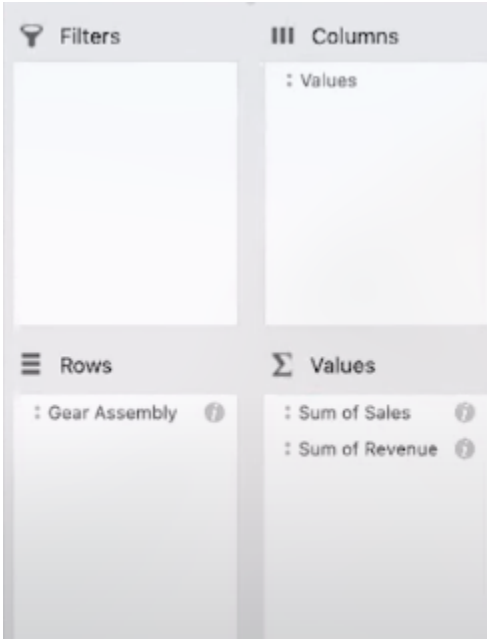
GA vs Sales Volume Analysis



- With the announcement of deprecation of BS4, the manufacturers increased BS4 manufacture temporarily in Q3 FY20 before totally discontinuing it, so that they can keep some inventory for people who still require it.

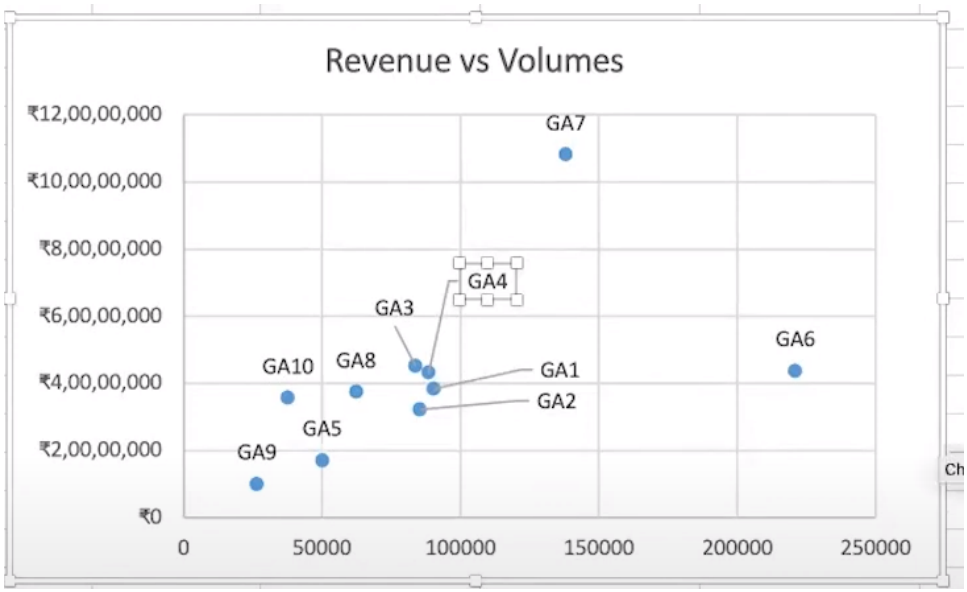
Revenue vs Volume Scatter Plot - Portfolio Analysis

We create a pivot table from the data



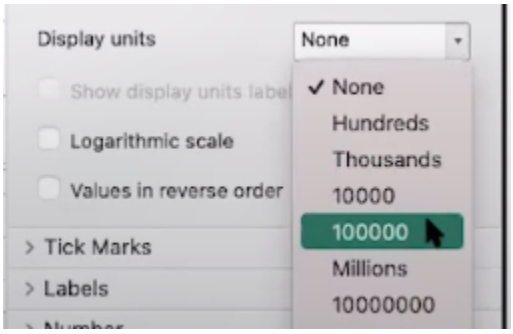
72	Row Labels	Sum of Sales	Sum of Revenue
73	Gear Assembly 1 (BS4)	90300	₹3,84,31,440
74	Gear Assembly 2 (BS4)	85366	₹3,21,84,810
75	Gear Assembly 3 (BS4/6)	83644	₹4,52,26,620
76	Gear Assembly 4 (BS4/6)	88410	₹4,31,49,865
77	Gear Assembly 5 (BS4/6)	50154	₹1,70,54,490
78	Gear Assembly 6 (BS4/6)	221024	₹4,37,30,180
79	Gear Assembly 7 (BS4/6)	138076	₹10,81,89,740
80	Gear Assembly 8 (BS4/6)	62302	₹3,74,88,510
81	Gear Assembly 9 (BS6)	26530	₹1,00,81,400
82	Gear Assmbly 10 (BS6)	37766	₹3,56,88,870

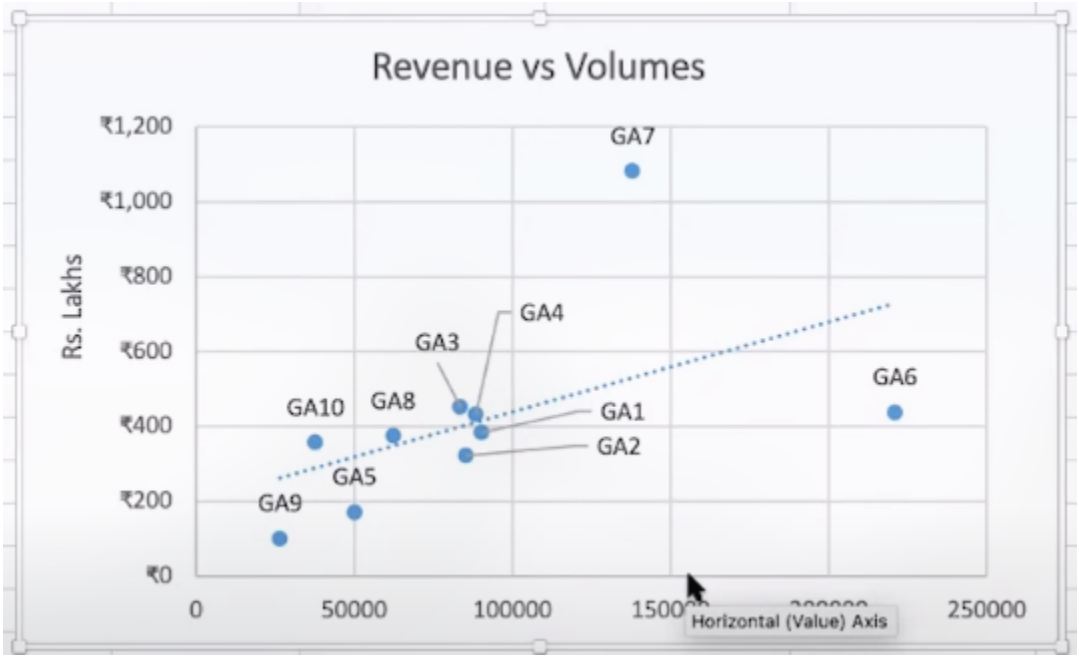
and then create a scatter plot from it.



- here GA7 and GA6 may be labelled as outliers
- all points seem to almost lie on diagonal
    - this is because all GA have similar price except GA7 and GA6 (7 costs more than average, 6 costs less than average)

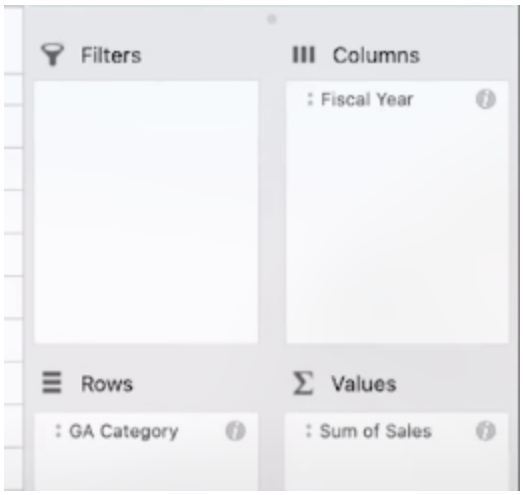
    - GA7 and GA6 are very popular GA
- We can plot a trendline instead of a 2x2 grid
- We can make the Y axis units more legible by converting it to Lakhs of INR





- GA9 is worst performer (as its newly introduced)

Analysis of BS4 vs BS6 Sales Volume over the FY

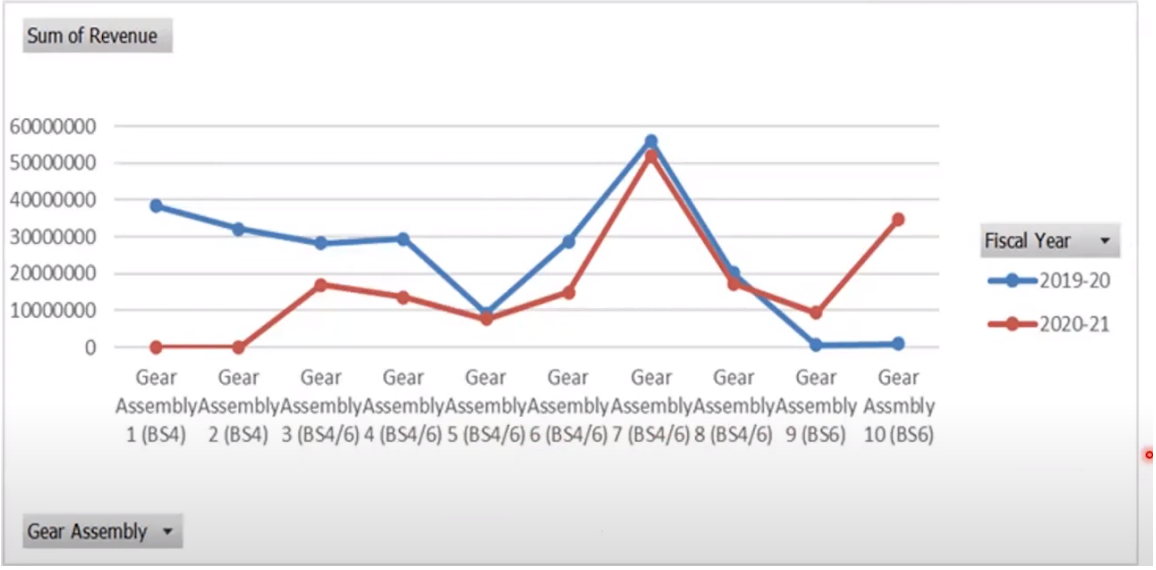


Sum of Sales	Column Labels		
Row Labels	FY19-20	FY20-21	Grand Total
BS4	175666	0	175666
BS4/BS6	395272	248338	643610
BS6	2895	61401	64296
Grand Total	**573833**	**309739**	**883572**

- We can see BS4 clearly died out in FY21
- BS6 production increased
- Common parts stayed almost same (reduced due to COVID)

Revenue of individual GA over FY

	2019-2021		2019-20		2020-21	
Gear Assembly	**Revenue**	**Rev in Lakhs**	**Revenue**	**Rev in Lakhs**	**Revenue**	**Rev in Lakhs**
Gear Assembly 1 (BS4)	3,84,31,440.00	384.31	3,84,31,440.00	384.31	0.00	0.00
Gear Assembly 2 (BS4)	3,21,84,810.00	321.85	3,21,84,810.00	321.85	0.00	0.00
Gear Assembly 3 (BS4/6)	4,52,26,620.00	452.27	2,82,48,000.00	282.48	1,69,78,620.00	169.79
Gear Assembly 4 (BS4/6)	4,31,49,865.00	431.50	2,95,02,385.00	295.02	1,36,47,480.00	136.47
Gear Assembly 5 (BS4/6)	1,70,54,490.00	170.54	92,64,090.00	92.64	77,90,400.00	77.90
Gear Assembly 6 (BS4/6)	4,37,30,180.00	437.30	2,87,18,430.00	287.18	1,50,11,750.00	150.12
Gear Assembly 7 (BS4/6)	10,81,89,740.00	1081.90	5,60,98,190.00	560.98	5,20,91,550.00	520.92
Gear Assembly 8 (BS4/6)	3,74,88,510.00	374.89	2,01,35,900.00	201.36	1,73,52,610.00	173.53
Gear Assembly 9 (BS6)	1,00,81,400.00	100.81	7,25,800.00	7.26	93,55,600.00	93.56
Gear Assembly 10 (BS6)	3,56,88,870.00	356.89	9,30,825.00	9.31	3,47,58,045.00	347.58
Grand Total	41,12,25,925.00	4112.26	24,42,39,870.00	2442.40	16,69,86,055.00	1669.86



GA Sales Volume

Gear Assembly	2019-20	2020-21	2019-21
Gear Assembly 1 (BS4)	90,300	0	90,300
Gear Assembly 2 (BS4)	85,366	0	85,366
Gear Assembly 3 (BS4/6)	52,800	30,844	83,644
Gear Assembly 4 (BS4/6)	60,558	27,852	88,410
Gear Assembly 5 (BS4/6)	27,654	22,500	50,154
Gear Assembly 6 (BS4/6)	1,47,274	73,750	2,21,024
Gear Assembly 7 (BS4/6)	73,366	64,710	1,38,076
Gear Assembly 8 (BS4/6)	33,620	28,682	62,302
Gear Assembly 9 (BS6)	1,910	24,620	26,530
Gear Assembly 10 (BS6)	985	36,781	37,766
Grand Total	**5,73,833**	**3,09,739**	**8,83,572**

Regional Analysis

For the regional data we have, we can create a table of Region vs Month and get the volume as values.

	Oct-19	Nov-19	Dec-19	Max Monthly Sales
North	16230	16645	11815	16645
East	17135	17695	8295	17695
West	5985	9640	7485	9640
South	14308	16691	13907	16691
Total	53658	60671	41502	

Now we take the max of each regions' volume in the rightmost column. A agent can handle 5000 sales himself, so we need $\frac{\text{max monthly sale}}{5000}$ agents.

Sales per agent		5000			
	Oct-19	Nov-19	Dec-19	Max Month	No of agents Needed
North	16230	16645	11815	16645	4
East	17135	17695	8295	17695	4
West	5985	9640	7485	9640	2
South	14308	16691	13907	16691	4
Total	53658	60671	41502		

We also know that the salary of a sales agent is ₹20,000 a month. So we can calculate the spend on sales agent for each region.

Cost of Sales Agent	₹20,000					
Sales per agent		5000				
	Oct-19	Nov-19	Dec-19	Max Month	No of agent	Sales Agent Budget
North	16230	16645	11815	16645	4	₹80,000
East	17135	17695	8295	17695	4	₹80,000
West	5985	9640	7485	9640	2	₹40,000
South	14308	16691	13907	16691	4	₹80,000
Total	53658	60671	41502	60671	14	₹2,80,000

Regionwise Revenue

We can do the same thing with the revenue. We have to use the price of each GA for respective months from the other sheet and multiply it with the quantity.

Regional Revenue Distribution	Oct 2019					Nov 2019		
	Overall	North	East	West	South	Overall	North	East
Gear Assembly 1 (BS4)	₹62,64,000	₹0	₹48,72,000	₹0	₹13,92,000	₹57,54,240	₹0	₹46,8
Gear Assembly 2 (BS4)	₹52,53,120	₹37,48,700	₹4,27,500	₹0	₹10,76,920	₹45,78,240	₹30,97,000	₹3,7
Gear Assembly 3 (BS4/6)	₹15,40,800	₹0	₹0	₹15,40,800	₹0	₹32,10,000	₹0	
Gear Assembly 4 (BS4/6)	₹17,64,000	₹8,59,950	₹0	₹9,04,050	₹0	₹21,75,600	₹12,54,400	
Gear Assembly 5 (BS4/6)	₹6,96,800	₹0	₹6,96,800	₹0	₹0	₹6,43,200	₹0	₹6,4
Gear Assembly 6 (BS4/6)	₹19,57,800	₹6,53,250	₹3,47,100	₹2,45,700	₹7,11,750	₹30,53,505	₹9,26,250	₹5,5
Gear Assembly 7 (BS4/6)	₹45,35,370	₹10,14,300	₹7,64,750	₹0	₹27,56,320	₹41,24,820	₹9,53,925	₹8,8
Gear Assembly 8 (BS4/6)	₹7,26,000	₹0	₹0	₹0	₹7,26,000	₹13,06,800	₹0	
Total	₹2,27,37,890	₹62,76,200	₹71,08,150	₹26,90,550	₹66,62,990	₹2,48,46,405	₹62,31,575	₹71,4
0								

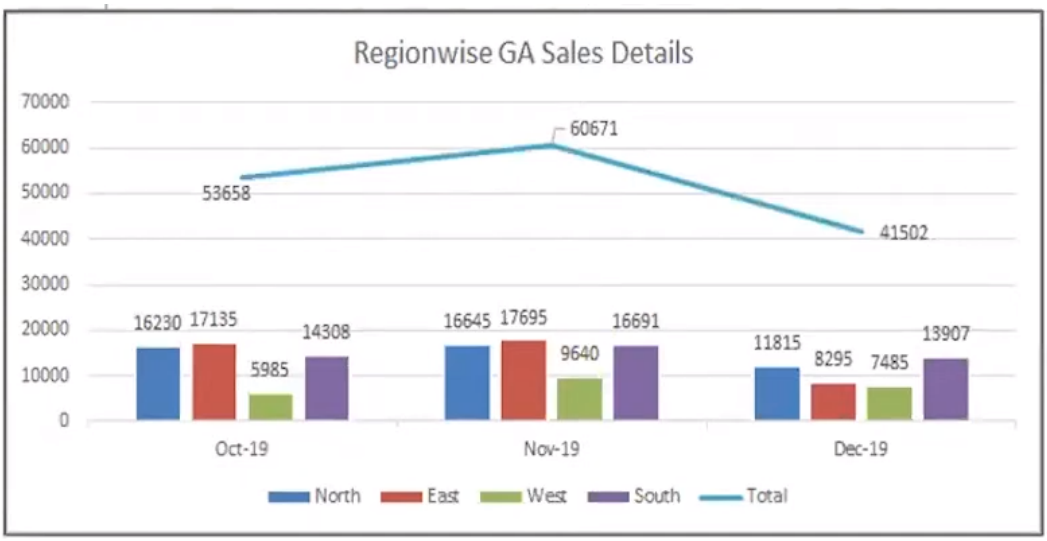
Regionwise Summary

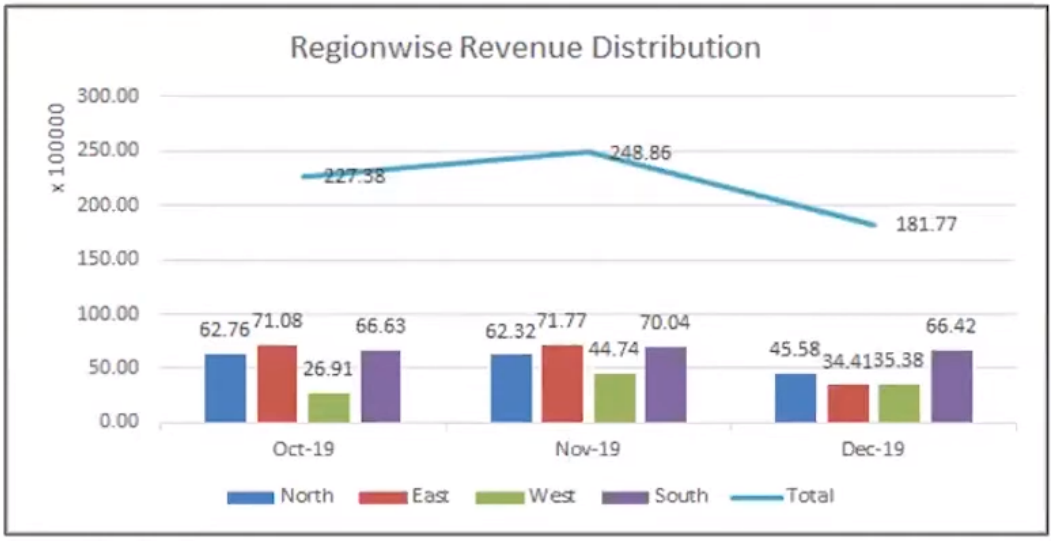
1. Revenue Receipts of Each Region

Region	Oct-19	Nov-19	Dec-19	Total Revenue
North	62,76,200	6231575	45,57,600	**1,70,65,375**
East	71,08,150	7176550	34,40,800	**1,77,25,500**
West	26,90,550	4474400	35,37,500	**1,07,02,450**
South	66,62,990	7003840	66,41,510	**2,03,08,340**
Total	**2,27,37,890**	**2,48,86,365**	**1,81,77,410**	**6,58,01,665**

2. No. of Agents Needed and their Salary

Region	Oct-19 Volumes	Nov-19 Volumes	Dec-19 Volumes	Max	No. of Agents	Agent Salary/ Month
North	16,230	16,645	11,815	16,645	4	**80,000**
East	17,135	17,695	8,295	17,695	4	**80,000**
West	5,985	9,640	7,485	9,640	2	**40,000**
South	14,308	16,691	13,907	16,691	4	**80,000**
Total	**53,658**	**60,671**	**41,502**	**60,671**	**14**	**2,80,000**

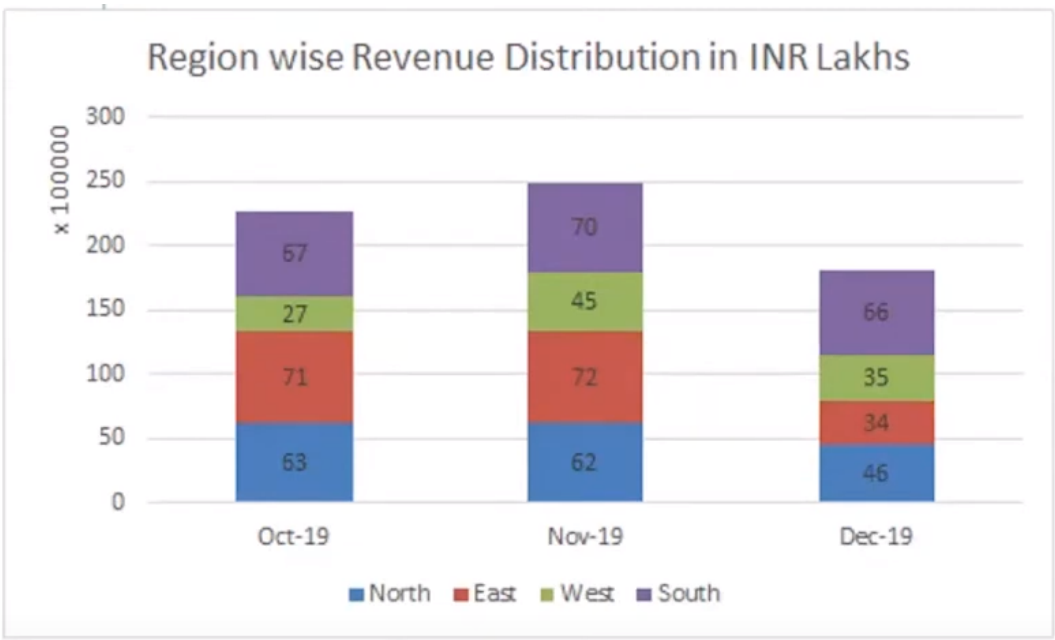


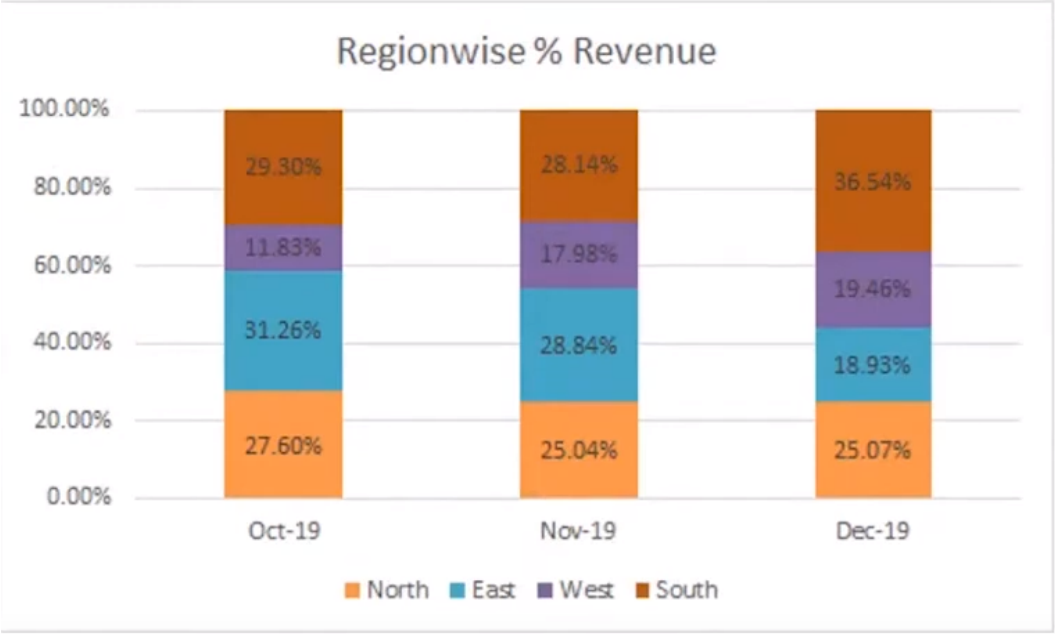


The analysis of agents is using the **farmer** theory instead of the **hunter** theory, although the hunter theory makes more sense, so West should actually have more agents than others.

> 💡 In the hunter vs farmer sales model, reps are separated into two distinct groups. Hunters are high-volume players, working to bring in and convert new leads, focused on closing deals. Farmers are relationship-builders; they work to cultivate the ‘field’ of existing customers into higher-value deals.

Other alternate visualizations


Region wise Revenue Distribution in INR Lakhs
x 100000
300
250
200
150
100
50
0
67
27
71
63
70
45
72
62
66
35
34
46
Oct-19
Nov-19
Dec-19
North
East
West
South


Regionwise % Revenue
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
29.30%
11.83%
31.26%
27.60%
28.14%
17.98%
28.84%
25.04%
36.54%
19.46%
18.93%
25.07%
Oct-19
Nov-19
Dec-19
North
East
West
South

Gear Manufacture, Scraps, OEE, Margins

Tags	OEE, margin analysis, plan vs actual, production, reorder, safety stock, scheduling, scrap, scrap cost, unit level profitability
Course	BDM
# Week	8
Created time	@August 29, 2023 12:15 AM

Gear Manufacture

Lets compare the production plan vs reality

Some Data Legends

Process Details
Workstation 1 - Hobbing (Standard Scrap - 2.5%)
Workstation 2 - Broaching
Target Production Load = 800 units per day on alternate weeks on Workstation 1, 780 units per day on alternate weeks fro Workstation 2
Total Target Production = 9000 units
Hobbing Maintenance - Saturday Second Shift
Broaching Maintenance - Monday first shift
Hobbing Changeover - Monday First Shift
Broaching Changeover - Monday Second Shift
Actual Final Output = 8690 units

Gears are made in two step process

- Hobbing
- Broaching

Broaching can only be done after hobbing is complete. Input of broaching is the output of hobbing.

Scrap

> 💡 Manufacturing scrap is the **unusable material from a manufacturing operation that will be discarded**. Scrap can be subdivided into several categories while used as a general definition for all rejected material.

Some amount of hobbing output can be scrap, thus unable to be used for broaching.

Hobbing Plan Calendar

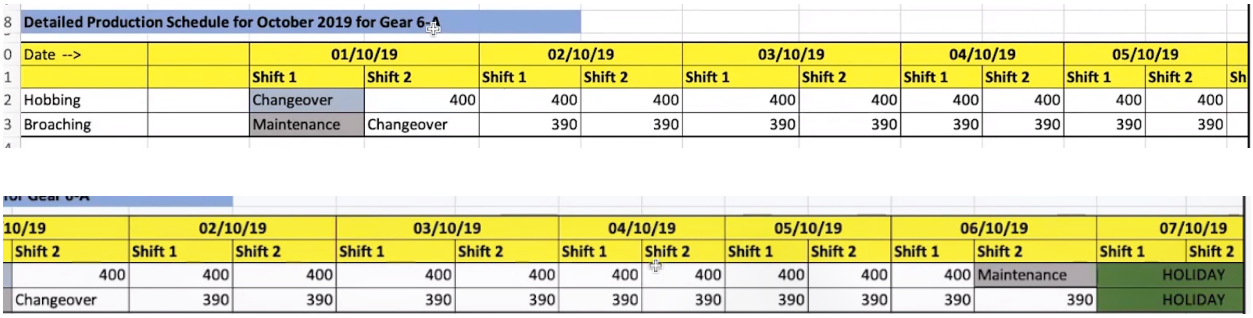
October 2019 - Production Load Schedule - Hobbing Workstation							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Date		**1**	**2**	**3**	**4**	**5**	**6**
Quantity		400	800	800	800	800	400
Date	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Quantity		0	0	0	0	0	0
Date	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Quantity		400	800	800	800	400	800
Date	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Quantity		0	0	0	0	0	0
Date	**28**	**29**	**30**	**31**			
Quantity		400	800	800			

Broaching Plan Calendar

October 2019 - Production Load Schedule - Broaching Workstation							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Date		1	2	3	4	5	6
Quantity		0	780	780	780	780	780
Date	7	8	9	10	11	12	13
Quantity		0	0	0	0	0	0
Date	14	15	16	17	18	19	20
Quantity		0	780	780	780	780	780
Date	21	22	23	24	25	26	27
Quantity		0	0	0	0	0	0
Date	28	29	30	31			
Quantity		0	780	780			

The broaching planned load is 97.5% of the expected hobbing load, as 2.5% is expected to be scrap.

Detailed Production Schedule (Shiftwise)



Detailed Production Schedule for October 2019 for Gear 6-A													
Date -->		01/10/19		02/10/19		03/10/19		04/10/19		05/10/19			
		Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Sh	
Hobbing		Changeover	400	400	400	400	400	400	400	400	400		
Broaching		Maintenance	Changeover	390	390	390	390	390	390	390	390		

10/19		02/10/19		03/10/19		04/10/19		05/10/19		06/10/19		07/10/19	
Shift 2		Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2
400		400	400	400	400	400	400	400	400	400	Maintenance	HOLIDAY	
Changeover		390	390	390	390	390	390	390	390	390	390	HOLIDAY	

The first shift of a week is always a changeover for hobbing (from some other gear to this gear)

The last day (saturday) of week has the last shift of hobbing dedicated to maintaince of machine.

Similarly the first shift of a week is always a maiintenance for broaching workstation.

The second shift of first day of week is changeover for broaching workstation.

The first output of hobbing after shift2 of day1 is fed into broaching in shift1 of day2.

So each shift output of hobbing is input of next shift broaching.

Date -->		01/10/19		02/10/19		
		Shift 1	Shift 2	Shift 1	Shift 2	Sh
Hobbing		Changeover	400	400	400	
Broaching		Maintenance	Changeover	390	390	

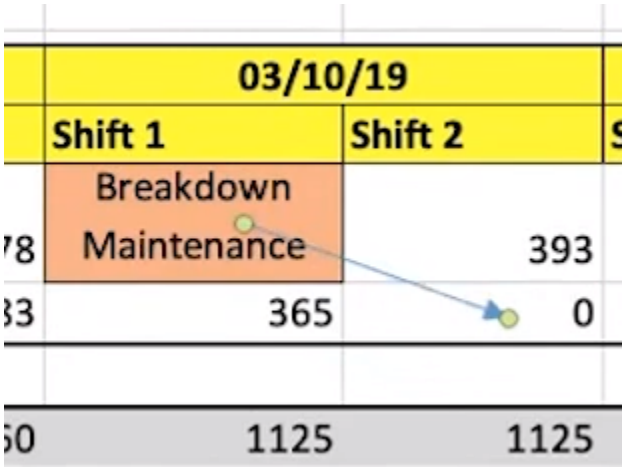
Actual Output (Shiftwise)

35	Actual Production Output for Oct 2019 for Gear 6-A											
37	Date -->		01/10/19		02/10/19		03/10/19		04/10/19		05/10/19	
38			Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2
39	Hobbing		Changeover	388	390	378	Breakdown Maintenance	393	384	386	380	378
40	Broaching		Maintenance	Changeover	377	383	365	0	386	378	376	373
41												
42	Cumulative Monthly Output				377	760	1125	1125	1511	1889	2264	2637

Here we can see the actual output of each shift of hobbing and broaching.

There are

- lower than planned output of hobbing and broaching
- some days there is emergency maintenance due to breakdown in hobbing and broaching

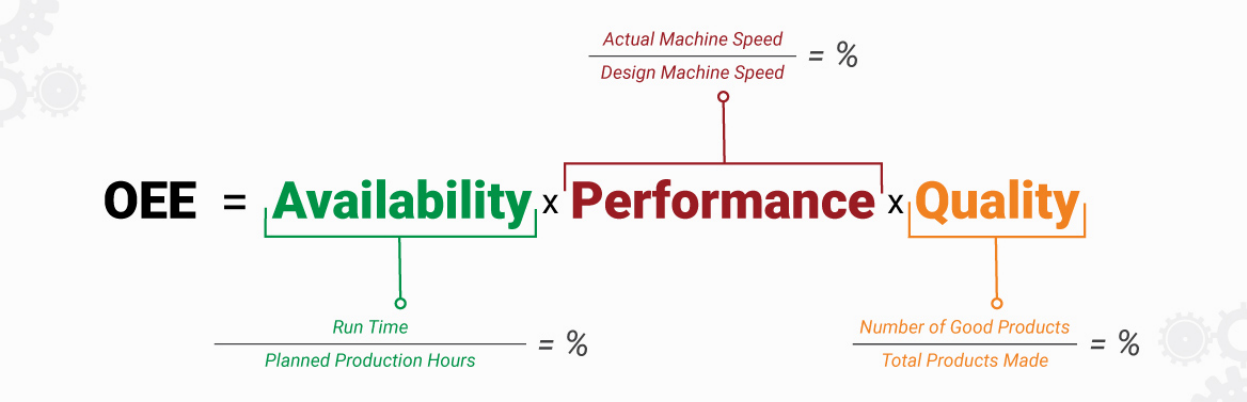


breakdown of hobbing affects output of broaching in next shift.

OEE: Overall Equipment Effectiveness*

💡 OEE (Overall Equipment Effectiveness) is the gold standard for measuring manufacturing productivity. Simply put – it identifies the percentage of manufacturing time that is truly productive. An OEE score of 100% means you are manufacturing only Good Parts, as fast as possible, with no Stop Time. In the language of OEE that means 100% Quality (only Good Parts), 100% Performance (as fast as possible), and 100% Availability (no Stop Time).

Measuring OEE is a manufacturing best practice. By measuring OEE and the underlying losses, you will gain important insights on how to systematically improve your manufacturing process. OEE is the single best metric for identifying losses, benchmarking progress, and improving the productivity of manufacturing equipment (i.e., eliminating waste).



if Availablity is A

$$A = \frac{\text{Run Time}}{\text{Planned Production Hours}}$$

Performance is P

$$P = \frac{\text{Actual Machine Speed}}{\text{Design Machine Speed}}$$

and Quality is Q

$$Q = \frac{\text{Number of Good Products}}{\text{Total Products Made}}$$

Then OEE =

$$\text{OEE} = A \times P \times Q$$

or in other words

OEE = ratio of times production line was online * ratio of production speed to planned speed * ratio of good output to all output

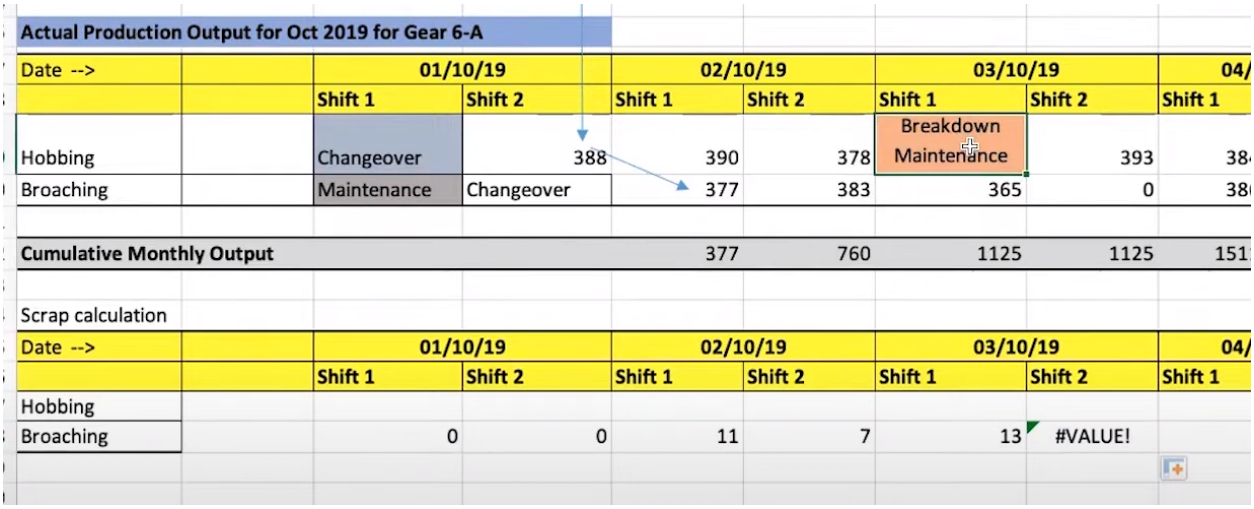
or, OEE depends on:

- Downtime (non working machines)
- Slow Machines
- Faulty Machines (scrap)

The Availablity depends on the Maintenance crew's competence, the Quality depends on the shift worker's competence, and Quality depends on shift worker and material sourcer's competence.

Scrap Calculation

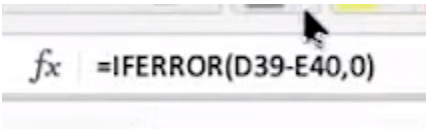
We can calculate the scrap of each shift by subtracting hobbing output with broaching output (assuming no scrap in broaching).



Actual Production Output for Oct 2019 for Gear 6-A								
Date -->		01/10/19		02/10/19		03/10/19		04/
		Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1
Hobbing		Changeover	388	390	378	Breakdown Maintenance	393	38
Broaching		Maintenance	Changeover	377	383	365	0	38
Cumulative Monthly Output				377	760	1125	1125	151
Scrap calculation								
Date -->		01/10/19		02/10/19		03/10/19		04/
		Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1
Hobbing								
Broaching		0	0	11	7	13	#VALUE!	

But as you can see we cannot subtract when there is some text in the cells, here we use `IFERROR`

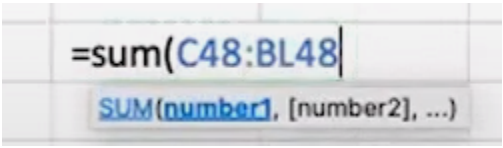
> 💡 You can use the IFERROR function to trap and handle errors in a formula. IFERROR returns a value you specify if a formula evaluates to an error; otherwise, it returns the result of the formula.



Now it works,

44													
45	01/10/19		02/10/19		03/10/19		04/10/19		05/10/19		06/10/19		
46	hift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1	Shift 2	Shift 1
47													
48	0	0	11	7	13	0	7	6	10	7	4	6	
49													

Now we can sum the row to get total scrap:



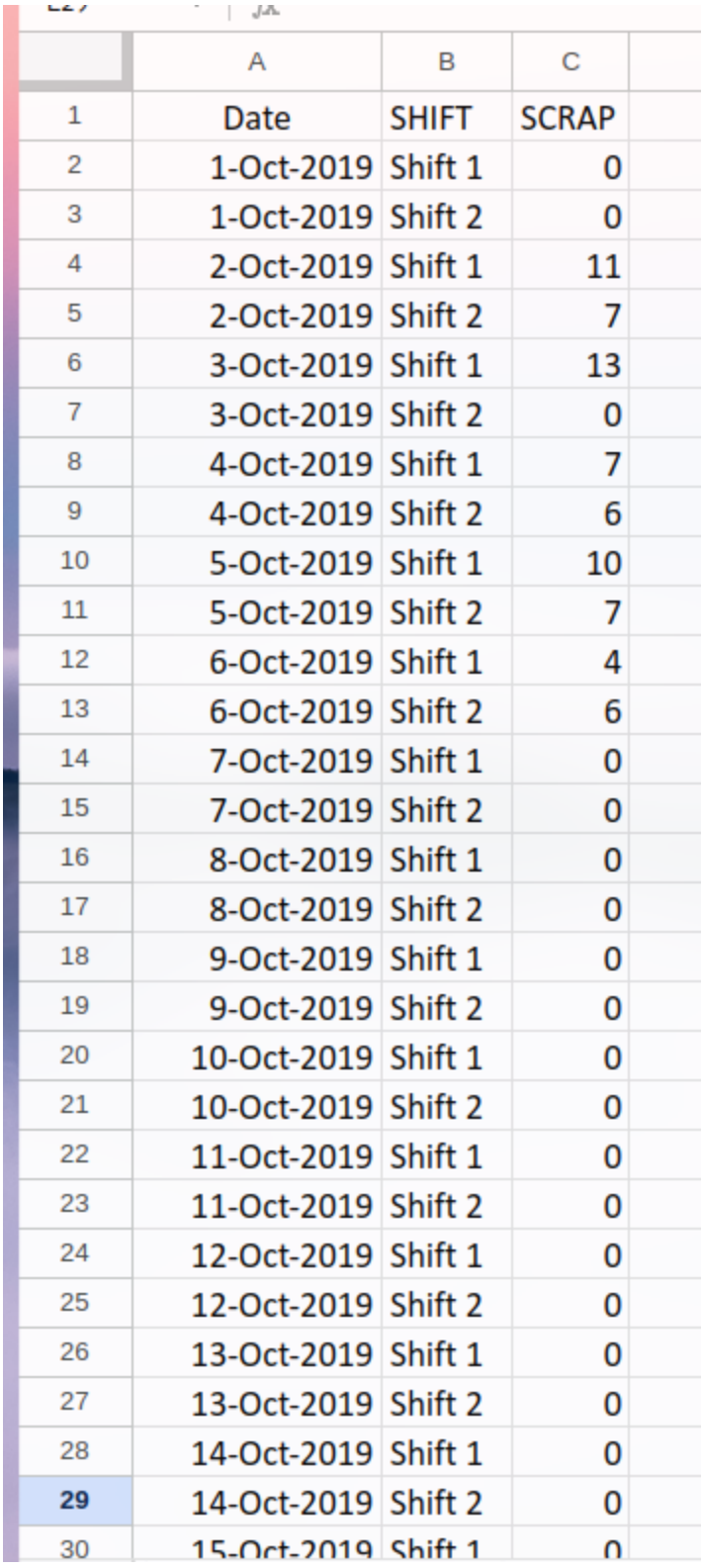
We can also find what percentage of output is scrap

Total Output	8313
Total Scrap	128
Perc Scrap	1.54%

So the scrap production is less than expected. But the total production is also lower than plan.

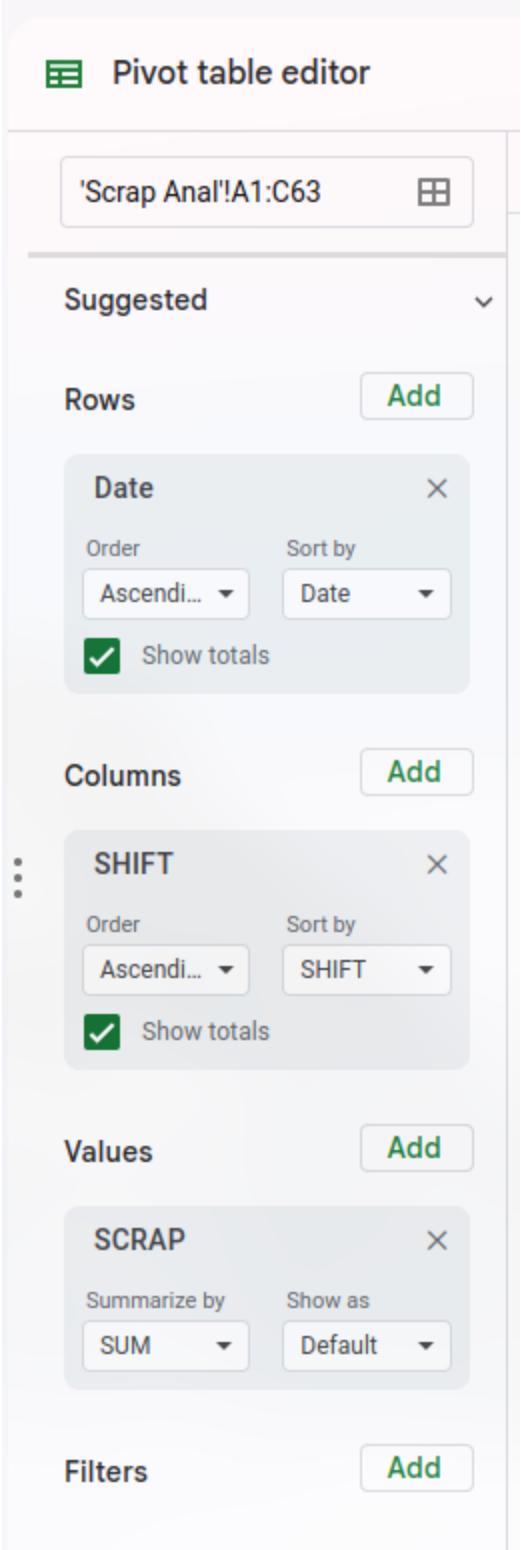
Charting of Scrap

Finally we can transpose the data into a table format and sanitize the data



	A	B	C
1	Date	SHIFT	SCRAP
2	1-Oct-2019	Shift 1	0
3	1-Oct-2019	Shift 2	0
4	2-Oct-2019	Shift 1	11
5	2-Oct-2019	Shift 2	7
6	3-Oct-2019	Shift 1	13
7	3-Oct-2019	Shift 2	0
8	4-Oct-2019	Shift 1	7
9	4-Oct-2019	Shift 2	6
10	5-Oct-2019	Shift 1	10
11	5-Oct-2019	Shift 2	7
12	6-Oct-2019	Shift 1	4
13	6-Oct-2019	Shift 2	6
14	7-Oct-2019	Shift 1	0
15	7-Oct-2019	Shift 2	0
16	8-Oct-2019	Shift 1	0
17	8-Oct-2019	Shift 2	0
18	9-Oct-2019	Shift 1	0
19	9-Oct-2019	Shift 2	0
20	10-Oct-2019	Shift 1	0
21	10-Oct-2019	Shift 2	0
22	11-Oct-2019	Shift 1	0
23	11-Oct-2019	Shift 2	0
24	12-Oct-2019	Shift 1	0
25	12-Oct-2019	Shift 2	0
26	13-Oct-2019	Shift 1	0
27	13-Oct-2019	Shift 2	0
28	14-Oct-2019	Shift 1	0
29	14-Oct-2019	Shift 2	0
30	15-Oct-2019	Shift 1	0

Then we can create a pivot table to pivot around date and shift

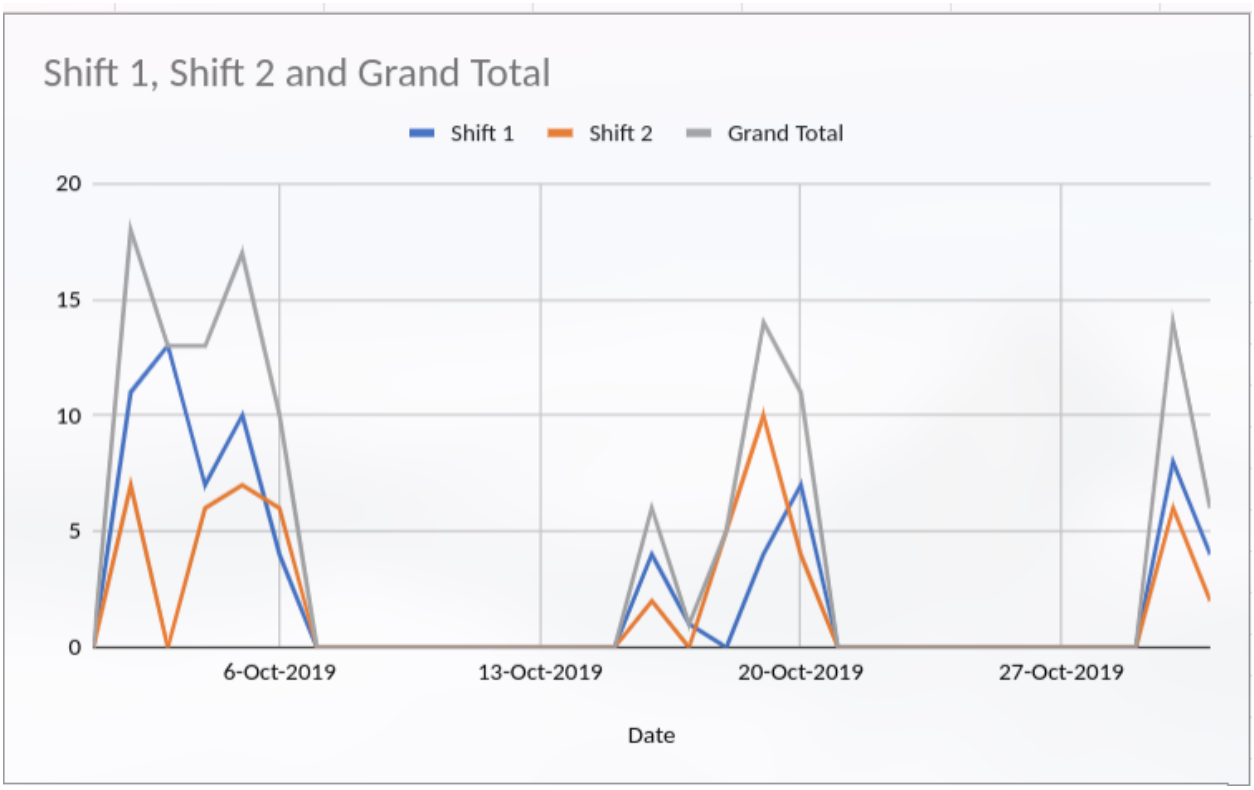

Pivot table editor
'Scrap Anal'!A1:C63
Suggested
Rows
Add
Date
Order
Ascendi...
Sort by
Date
Show totals
Columns
Add
SHIFT
Order
Ascendi...
Sort by
SHIFT
Show totals
Values
Add
SCRAP
Summarize by
SUM
Show as
Default
Filters
Add

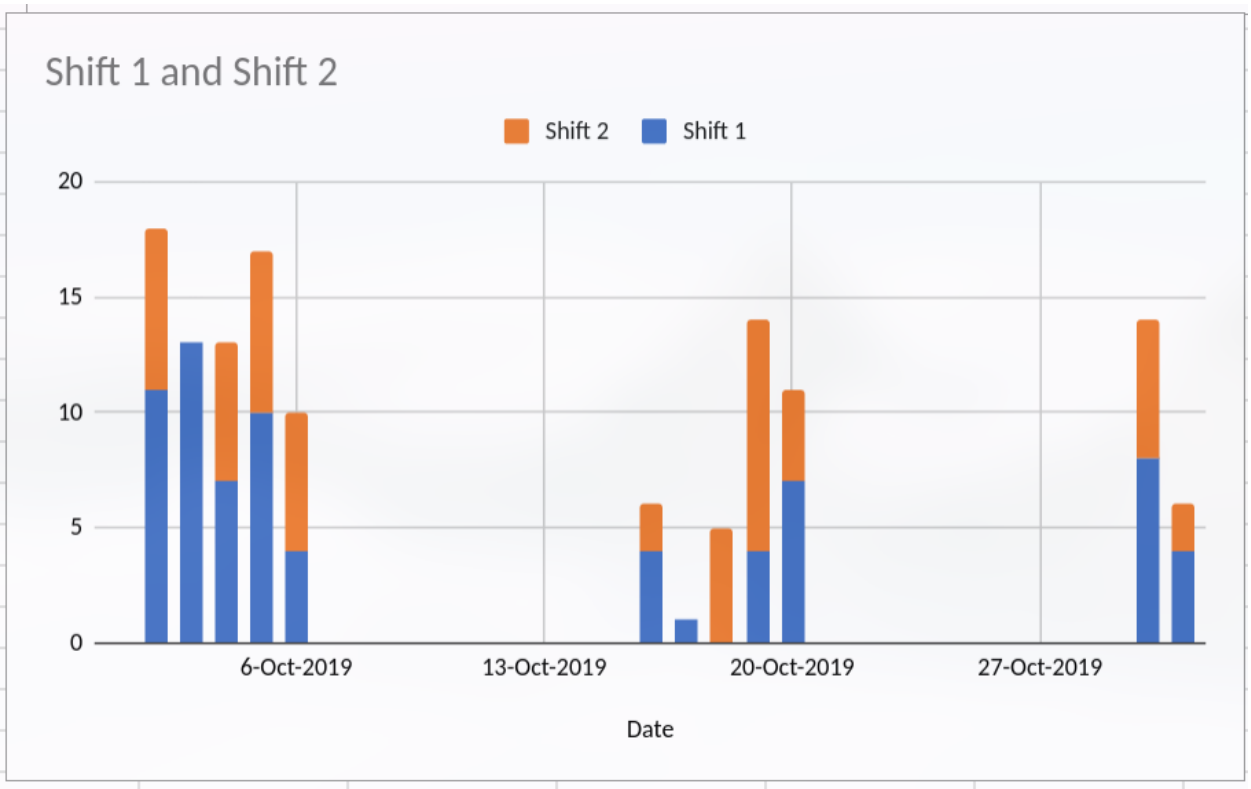
SUM of SCRAP	SHIFT		
Date	Shift 1	Shift 2	Grand Total
1-Oct-2019	0	0	0
2-Oct-2019	11	7	18
3-Oct-2019	13	0	13
4-Oct-2019	7	6	13
5-Oct-2019	10	7	17
6-Oct-2019	4	6	10
7-Oct-2019	0	0	0
8-Oct-2019	0	0	0
9-Oct-2019	0	0	0
10-Oct-2019	0	0	0
11-Oct-2019	0	0	0
12-Oct-2019	0	0	0
13-Oct-2019	0	0	0
14-Oct-2019	0	0	0
15-Oct-2019	0	0	0
16-Oct-2019	4	2	6
17-Oct-2019	1	0	1
18-Oct-2019	0	5	5
19-Oct-2019	4	10	14
20-Oct-2019	7	4	11
21-Oct-2019	0	0	0
22-Oct-2019	0	0	0
23-Oct-2019	0	0	0
24-Oct-2019	0	0	0
25-Oct-2019	0	0	0

SUM of SCRAP	SHIFT		
Date	Shift 1	Shift 2	Grand Total
Grand Total	**73**	**55**	**128**

We can see shift 1 produces more scrap than shift 2.

Finally we can chart the table





We can see shift 1 almost always produces more scraps than shift 2.

Material Cost of Scrap

We can calculate the amount of money lost on the raw materials due to scrap. We multiply the number of scraps with the cost of the blank needed for that gear.

```
=C53*Blank_Cost!B4
```

6	Material cost of scrap	4480
7		

OEE Calculation

- We calculate Availablity as ratio of actual shifts by planned shifts, or more clearly,

$$\frac{\text{Planned Shifts} - \text{Breakdown Shifts}}{\text{Planned Shifts}}$$

- We cacluate Performance as ratio of actual output by planned output (hobbing)
- We calculate the Quality as the ratio of actual broaching output by actual hobbing output which is input for broaching (non-scrap by all)

We exclude the last shift of hobbing output as that is not counted in broaching input.

48				if broach				
49	**Total Scrap**		**128**	511			**Total Output**	8313
50	**Scrap Cost**		**8320**	33215			**Total Scrap**	128
51							**Perc Scrap**	1.54%
52	**OEE**	original	planned	ratio				
53	**Availablity**	47	49	95.92%	actual shifts	/	plan shifts	
54	**Performance**	9213	9600	95.97%	actual hob	/	plan hob	
55	**Quality**	8696	8824	98.55%	broach input - scrap	/	broach input	
56	**OEE**			**91%**				
57								

Unit Level Profitability

SALES DETAILS (GEAR ASSEMBLIES)	Average Sales Price (Oct 2020 - March 2021)	Direct Materials	Direct Labour	Production Overhead	Cost of Goods Sold	Gross Margin	Gross Margin %
Gear Assembly 3 (BS4/6)	555.00					555.00	100%
Gear Assembly 4 (BS4/6)	490.00					490.00	100%
Gear Assembly 5 (BS4/6)	350.00					350.00	100%
Gear Assembly 6 (BS4/6)	205.00					205.00	100%

We have the average sales price of each GA, but we need to know the cost of manufacturing each GA (per unit) as well to find out profit margin.

Some components of cost are:

- Material Cost
- Labour Cost
- Production Overhead
- General and Administrative Overhead (G&A)

Material Cost is cost of blank needed for A + cost of blank needed for B of that GA.

The Material Cost can be calculated from the data provided of blank cost.

Part Number	Per Unit Cost
Blank-011	105
Blank-012	65
Blank-021	47
Blank-022	25

and the blank-gear relation table

GEAR	Gear Assembly	MATCHING PART NO.
Gear 2-A	Gear Assembly 2 (BS4)	Blank-001
Gear 2-B	Gear Assembly 2 (BS4)	Blank-002
Gear 3-A	Gear Assembly 3 (BS4/6)	Blank-011
Gear 3-B	Gear Assembly 3 (BS4/6)	Blank-021
Gear 4-A	Gear Assembly 4 (BS4/6)	Blank-011
Gear 4-B	Gear Assembly 4 (BS4/6)	Blank-022
Gear 5-A	Gear Assembly 5 (BS4/6)	Blank-012
Gear 5-B	Gear Assembly 5 (BS4/6)	Blank-021
Gear 6-A	Gear Assembly 6 (BS4/6)	Blank-012
Gear 6-B	Gear Assembly 6 (BS4/6)	Blank-022

we can lookup cost of each blank in this table from the previous table

GEAR	Gear Assembly	MATCHING PART NO.	blank cost
Gear 2-A	Gear Assembly 2 (BS4)	Blank-001	#N/A
Gear 2-B	Gear Assembly 2 (BS4)	Blank-002	#N/A
Gear 3-A	Gear Assembly 3 (BS4/6)	Blank-011	105
Gear 3-B	Gear Assembly 3 (BS4/6)	Blank-021	47
Gear 4-A	Gear Assembly 4 (BS4/6)	Blank-011	105
Gear 4-B	Gear Assembly 4 (BS4/6)	Blank-022	25
Gear 5-A	Gear Assembly 5 (BS4/6)	Blank-012	65
Gear 5-B	Gear Assembly 5 (BS4/6)	Blank-021	47
Gear 6-A	Gear Assembly 6 (BS4/6)	Blank-012	65
Gear 6-B	Gear Assembly 6 (BS4/6)	Blank-022	25

and finally pivot over the GA using sum of blank cost

Gear Assembly	SUM of blank cost
Gear Assembly 3 (BS4/6)	152
Gear Assembly 4 (BS4/6)	130
Gear Assembly 5 (BS4/6)	112
Gear Assembly 6 (BS4/6)	90
Grand Total	**484**

So now we have the material cost of each GA.

The labour cost, production cost, G&A Cost cannot be calculated from the given data, so it is provided.

SALES DETAILS (GEAR ASSEMBLIES)	Sales Price	Direct Labour	Production Overhead	G&A Overhead
Gear Assembly 3 (BS4/6)	555.00	95	165	45
Gear Assembly 4 (BS4/6)	490.00	65	145	45
Gear Assembly 5 (BS4/6)	350.00	35	115	45
Gear Assembly 6 (BS4/6)	205.00	25	45	45

- Usually Labour cost will be cost over all the labours for a production line (salary, bonus, etc) divided by number of gear assemblies produced by that line.
- Production Overhead is the cost of things like maintenance crew, lighting and electricity, production supervisor, factory manager, lubrication costs, cleaning, etc. It is then aportioned into the GAs according to their share of volume output.
- G&A Overhead are all the costs that occur outside the factory like sales team, distribution team, management team, warehouse cost, head office cost, etc.

Cost of production of GA is $\text{Direct Material Cost} + \text{Direct Labour Cost} + \text{Production Overhead Cost}$

> 💡 The G&A Overhead is not considered in cost for gross margin, it is only subtracted later from gross margin to get net margin. [W8L6 8:05]

Gross Margin

$$\text{Gross Margin} = \text{Average Sales Price of GA} - \text{Cost of GA}$$

Blank Ledger

We need to source the raw materials of blanks.

The order quantity should reflect the quantity used in production and the inventory.

BLANK INVENTORY & PURCHASES								
	Mar-19		Apr-19	*May-19*	Jun-19	*Jul-19*	Aug-19	*Sep-19*
	End Invt.	Ordr Qty	Prod. Issues	Prod. Issues	Prod. Issues	Prod. Issues	Prod. Issues	Prod. Issues
Blank-001	11230	7698	6270	6875	10835	8679	9845	13574
Blank-002	10940	7711	6391	6974	10637	8525	10087	13442
Blank-011	18760	7840	11781	18766	15059	8085	5461	2827
Blank-012	23005	12859	12650	18832	18370	17886	11451	10840
Blank-021	13780	6287	11891	13783	8767	7210	3916	121
Blank-022	25890	14233	12617	22275	25894	16632	9394	14954

Prod Issues: the number of blanks used in that month

End Invt.: the inventory amount at that time

Order Qty: the amount of new blanks bought

The ordered quantity will be delivered in the next month (1 month lead time)

> 💡 “Order Lead Time means the minimum amount of time (outlined in the applicable Statement of Work) between the date on which a Purchase Order is received by Supplier and the date for the delivery of the Product to the shipping location designated by Customer, as set forth in such Purchase Order.”

ABC Analysis

Inventory Items are classified into three categories, A, B, and C. A is high value and tightly controlled, B is medium , C is low value and loosely controlled.

Category	Value	Control	Record Maintenance	Purchase/ Inventory Strategies
A	High	Tightly Controlled	Accurate	Just-in-Time, Planned Orders
B	Medium	Moderately Controlled	Good	Planned Orders (Safety Stock)
C	Low	Minimally Controlled	Simple	Economic Order Quantity

A usually contributes to 70-80% revenue but only 10-20% volume.

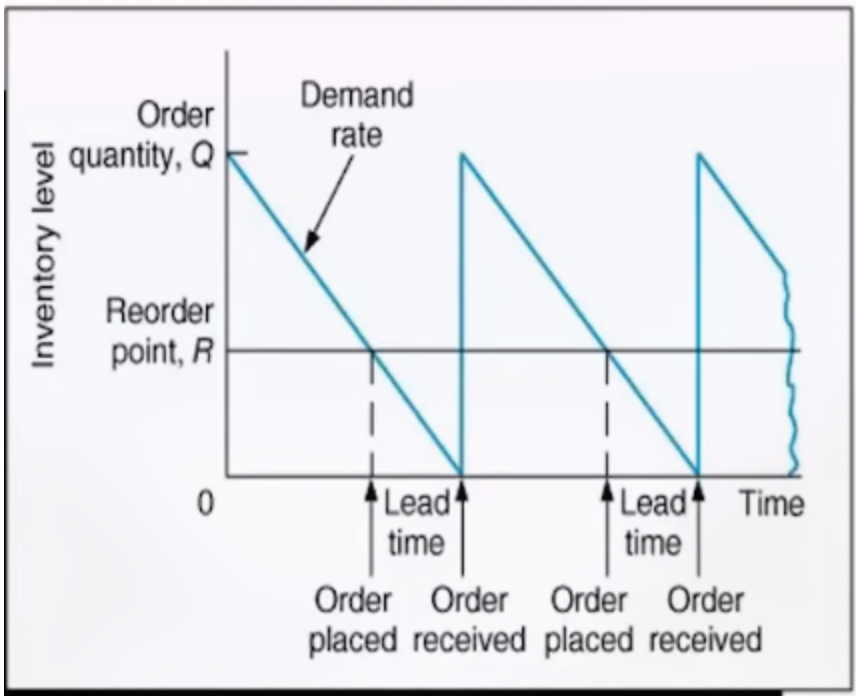
C is low value but high number (like nuts and bolts)

The **Gear Blanks** are category **B**. As they are important yet not high value. So we maintain a safety stock of gear blanks.

> 💡 Safety stock is **held when uncertainty exists in demand, supply, or manufacturing yield, and serves as an insurance against stockouts**. Safety stock is an additional quantity of an item held in the inventory to reduce the risk that the item will be out of stock.

$$\text{Safety Stock} = \text{Maximum Demand} - \text{Average Demand}$$

It is the amount of stock kept for exigencies.



Lead Time: It is the time taken for order request to be received.

Lead Time Demand: total demand of product during lead time. (assumed to be annual average)

Reorder Point (ROP): It is the minimum inventory or stock level for a specific product that triggers the reordering of more stock.

$$\text{Reorder Point} = \text{Demand during Lead Time} + \text{Safety Stock}$$

EOQ : Economic Order Quantity

It is the optimal quantity of material units that needs to be ordered at a time. It is a factor of **holding cost, ordering cost,** and **demand.**

$$Q = \sqrt{\frac{2 \times D \times S}{H}}$$

where $Q =$ EOQ units, $D =$ Demand in units (typically on an annual basis), $S =$ Order Cost (per purchase order), $H =$ Holding Cost (per unit, per year)

Economic Order Quantity, also known as Financial Purchase Quantity or Economic Buying Quantity, is the order quantity that minimizes the total holding costs and ordering costs in inventory management. It is one of the oldest classical production scheduling models.

Economic order quantity (EOQ) is the ideal quantity of units a company should purchase to meet demand while minimizing inventory costs such as holding costs, shortage costs, and order costs. This production-scheduling model was developed in 1913 by Ford W. Harris and has been refined over time. The economic order quantity formula assumes that demand, ordering, and holding costs all remain constant.

Gross Margin Percentage

The Gross Margin Percentage is calculated with respect to the **revenue** (or sales price) and not the cost price.

so,

$$GM\% = \frac{Revenue - COGS}{Revenue}\%$$

where COGS = Cost of Goods Sold

so it is $Margin/Revenue$

> 💡 Gross margin percentage is calculated using revenue (sales) because it provides insight into how efficiently a company produces its goods or services. It focuses on the relationship between revenue and the cost of goods sold (COGS), which represents the direct costs incurred in producing the products or services. This percentage indicates the portion of revenue that remains after deducting the direct costs of production. A higher gross margin percentage suggests that a company is able to cover its production costs while still retaining a larger portion of revenue as gross profit.

What-if Analysis

So we have calculated the Gross margin and GM% of the GAs.

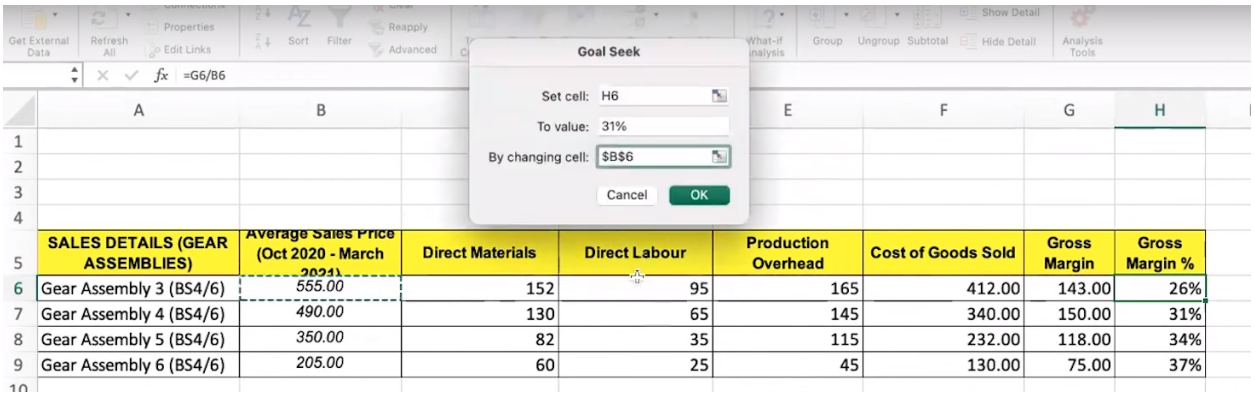
SALES DETAILS (GEAR ASSEMBLIES)	Average Sales Price (Oct 2020 - March 2021)	Direct Materials	Direct Labour	Production Overhead	Cost of Goods Sold	Gross Margin	Gross Margin %
Gear Assembly 3 (BS4/6)	555.00	152	95	165	412.00	143.00	26%
Gear Assembly 4 (BS4/6)	490.00	130	65	145	340.00	150.00	31%
Gear Assembly 5 (BS4/6)	350.00	82	35	115	232.00	118.00	34%
Gear Assembly 6 (BS4/6)	205.00	60	25	45	130.00	75.00	37%

As we can see, GA3 is having low GM%. We want to increase that. But it is hard to cut down on COGS, so only option is to increase the Sales Price. But what should be the sales price increased to so that GM% becomes (lets say) 31%?

It can cumbersome to guess or even calculate by hand, so we can use **What if Analysis** of Excel to find the value for us.

> 💡 What-If Analysis is **the process of changing the values in cells to see how those changes will affect the outcome of formulas on the worksheet**. Three kinds of What-If Analysis tools come with Excel: Scenarios, Goal Seek, and Data Tables.

Here we will use `Goal Seek` , as we have a goal of 31% margin.



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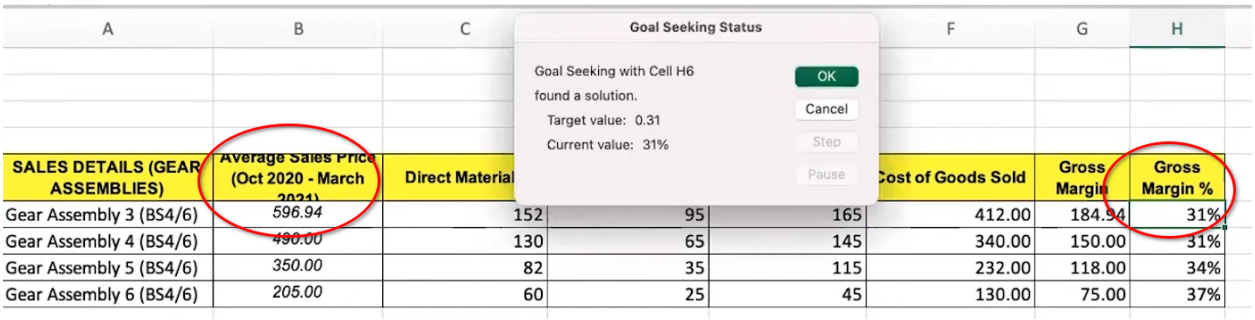


SALES DETAILS (GEAR ASSEMBLIES)	Average Sales Price (Oct 2020 - March 2021)	Direct Material			Cost of Goods Sold	Gross Margin	Gross Margin %
Gear Assembly 3 (BS4/6)	596.94	152	95	165	412.00	184.94	31%
Gear Assembly 4 (BS4/6)	490.00	130	65	145	340.00	150.00	31%
Gear Assembly 5 (BS4/6)	350.00	82	35	115	232.00	118.00	34%
Gear Assembly 6 (BS4/6)	205.00	60	25	45	130.00	75.00	37%

But according to industry, we cannot increase sales price in this industry (tier-1). So we have to cut down on costs.

Safety Stock and Re-ordering

We have the following data:

BLANK INVENTORY & PURCHASES								
	Mar-19		Apr-19					
Part No.	Inventory & Orders		Issues, Receipts, Orders					
	End Invt.	Ordr Qty	Prod. Issues	Purch. Rcpts.	End Invt.	Cum Deficit	Order Qty	Prod. Issues
Blank-001	11230	7698	6270	7698	12658	-1428	7698	687
Blank-011	18760	7840	11781	7840	14819	3941	7840	1876

where End Invt is the ending inventory

Order Quantiy is order placed in current month but received in next month

Prod. Issues is the amount of inventory used for production

Purchase Receipts is the orders of previous month finally being delivered to inventory

End Inventory this is = End Invt of prev month + Purch Recpt of current month - Prod Issue of current month

Cum Deficit is cumulative deficit from the ROP (reorder point)

But the data is formatted very poorly, we need to reorder the data in the following shape:

	Blank	Month	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-1
10									
11	Blank-001	Prod. Issue							
12	Blank-001	Order Quantity							
13	Blank-001	Purchase Receipts							
14	Blank-001	Ending Inventory							
15									
16		Month							
17	Blank-011	Prod. Issue							
18	Blank-011	Order Quantity							
19	Blank-011	Purchase Receipts							
20	Blank-011	Ending Inventory							

But we cannot directly refer one cell and extend the formula as each attribute is interleaved. For his we use the `OFFSET` function.

> 💡 Returns a reference to a range that is a specified number of rows and columns from a cell or range of cells. The reference that is returned can be a single cell or a range of cells. You can specify the number of rows and the number of columns to be returned.

```
Syntax
OFFSET(reference, rows, cols, [height], [width])
```

So for each month we have to skip 5 columns (as order of columns of each month is fixed and 5 in number). We can do this using `OFFSET` function and the current column count using `Column()` function.

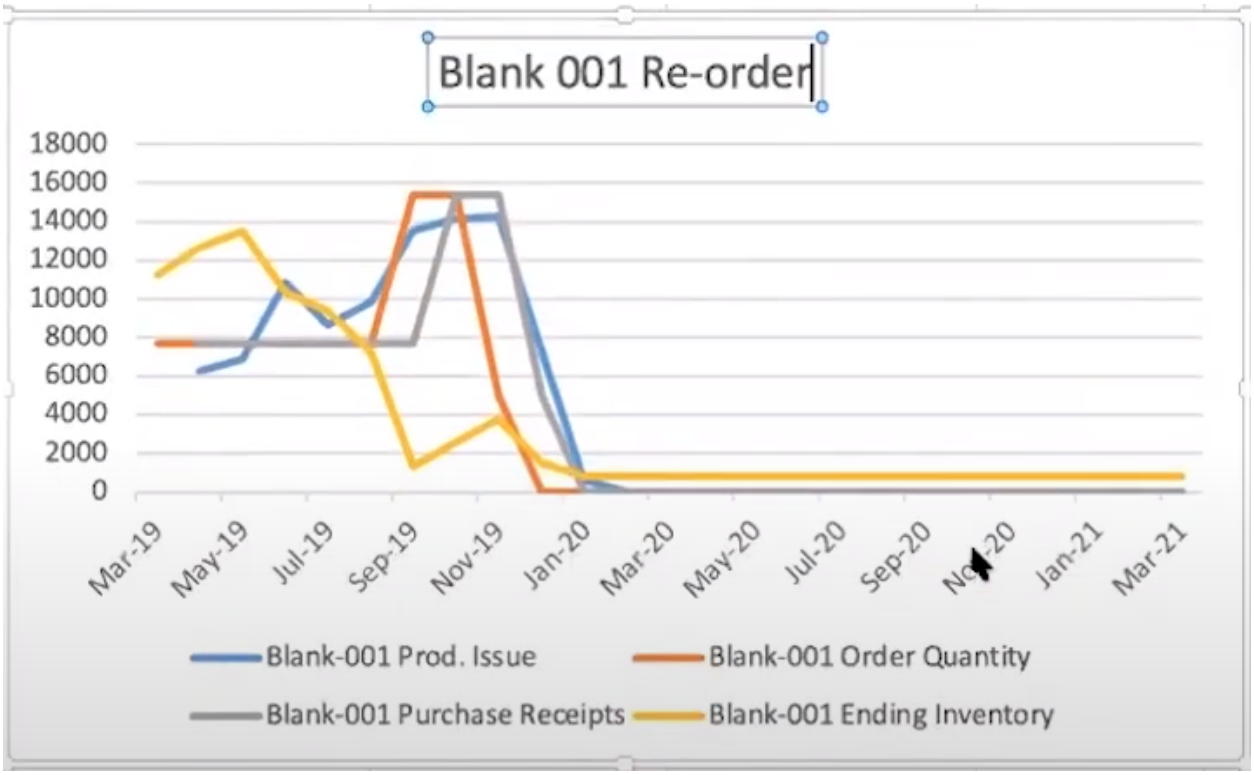
the `4` is due to the starting being from column D.

Similarly we can do for the rest of the rows.

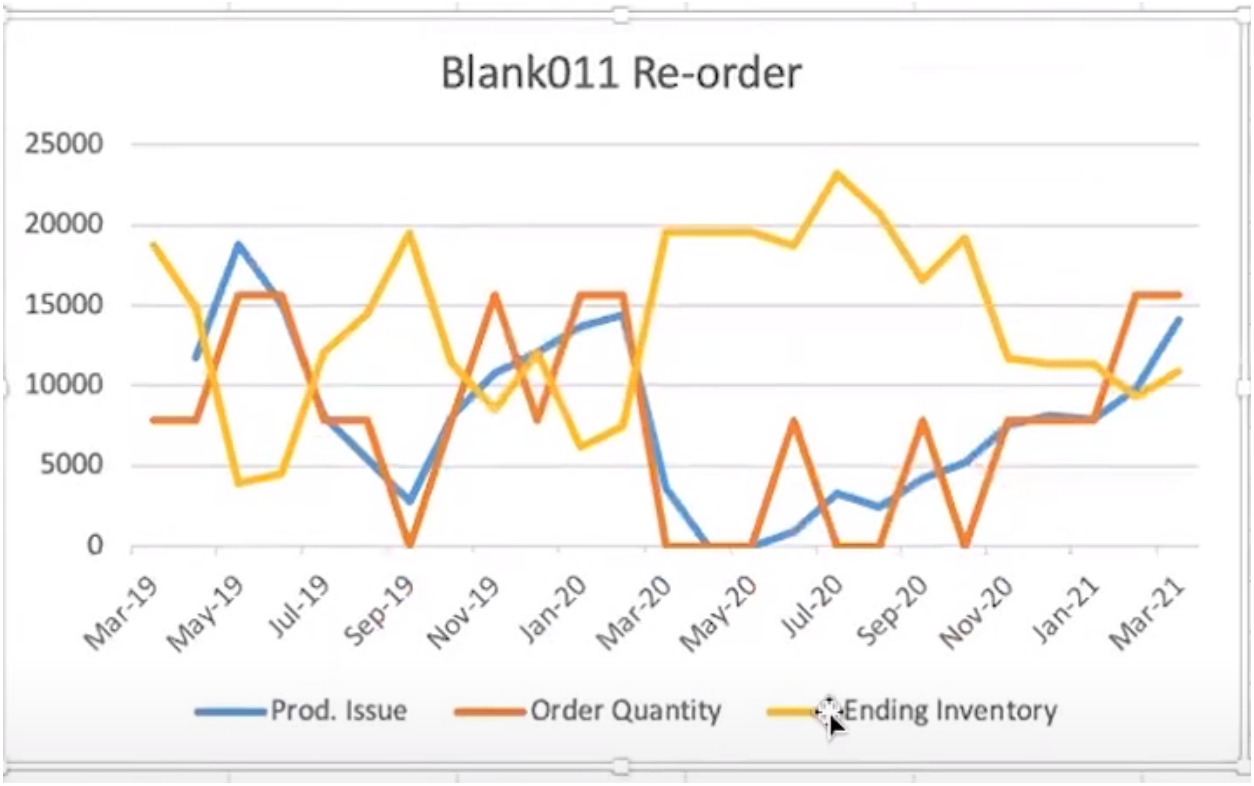
Month	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-1
Prod. Issue		6270	6875	10835	8679	9845	1357
Order Quantity	7698	7698	7698	7698	7698	7698	1539
Purchase Receipts		7698	7698	7698	7698	7698	769
Ending Inventory	11230	12658	13481	10344	9363	7216	134

Simiarly we can do for the other blank.

Now we can plot the data in a graph.



The Purchase Receipt and Order Qty are same graph translated one month as per definition.



We can observe that:

- order quantity tracks prod issue
- it is more staggered due to MOQ from supplier
- inventory decreases when prod issue increases at first and next month we get order delivery
- blank 001 was used for BS4 and thus is stopped now.

Safety Stock

So now we can calculate the safety stock by following the formula

Future Reorder Point Calculation					Order Qty Calculation	
Part No.	Safety Stock	LT Demand	Reorder Point	Reorder Quantity	Single Ord	Double Ord
Blank-001	6,547	7,698	14,245	7,698	7,698	15,396
Blank-011	10,926	7,840	18,766	7,840	7,840	15,680

Closing Remarks

- The order quantity is quantized due to fixed reorder quantity
  - Some months the inventory falls below ROP once, some months twice, some months never
- Some units of BS4 blank is left in warehouse never to be used again, it should be sold as scrap metal
- Due to the lead time we cannot properly synchronize inventory with production, so we see oscillations.

HR, Recruitment, Internal Sourcing, Ranking, Channels

Tags	HR, channel analysis, channel effectiveness, internal sourcing, job description, normalization, ranking, recruitment, selection criteria, unstructured data
Course	BDM
# Week	9
Created time	@August 29, 2023 3:34 PM

HR

> 💡 Human resources is the set of people who make up the workforce of an organization, business sector, industry, or economy. A narrower concept is human capital, the knowledge and skills which the individuals command. Similar terms include manpower, labor, or personnel.

Data in resume, job description, etc is unstructured. We need to choose parameters from there and normalize the parameters to rank people.

> 💡 Data normalization formula is **the method of scaling values to bring them to a common range**. It is used to process any data set so that they become comparable to other data set and can be used by anyone who wants to understand and interpret it.

There are many ways of normalizing data like:

- range scaling $(x - x_{min}) \div (x_{max} - x_{min})$
- feature clipping
- log scaling
- Z-score $(x - \mu)/\sigma$

> 💡 Note: μ is the mean and σ is the standard deviation.

But here we will use simple normalization of range scaling and assume x_{min} to be 0, so $x = x/x_{max}$

Manpower Planning

- putting right number of people and right kind of people
- at the right place and right time

- doing the right things with clarity on the expectations of them
- so that it helps the organization achieve its goals

Recruitment Process is the process of actively seeking out and finding and hiring canditates for a specific job position. This includes the entire hiring process, from inception to the individual recruit's integration into the company.

An organization needs to plan the future to prosper.

- Analyse current human resources, how many people, doing what kinds of work, getting what revenue for the organization
- create manpower forecasts - how many more people will we need to do how much more for the organization
- helps plan the labor cost
- helps in growth and diversification of business

> 💡 Glassdoor is an American website where current and former employees anonymously review companies.

Attrition Rate

> 💡 Attrition rate is **a metric that quantifies the rate at which employees depart an organisation, whether voluntarily or involuntarily**. It represents the pace of employee turnover, expressed as a percentage and serves as a key indicator for HR teams to evaluate retention efforts and understand organisational dynamics.

Example attrition rate of 18% is average for IT. Manufacturing would be 5-9%.

As there are more roles in IT, and bargaining power of employees is more, so attrition rate is high.

So HR has to constantly work to replace the leavers.

Some people are hired only to handle the recruitment and onboarding.

Internal Sourcing

> 💡 Internal sources of recruitment refer to **hiring employees within the organization internally**. In other words, applicants seeking for the different positions are those who are currently employed with the same organization.

This is faster and easier than external sourcing.

For higher level of positions IS makes sense, but not for entry level positions, as people already working would usually want to get a promotion, or rarely, do a lateral shift, but never a demotion.

Employees from current organization meeting some criteria like years of experience, good appraisal scores for two years, experience in relevant tools, etc.

Bench

> 💡 In the IT industry, the bench list refers to **the section of employees who are currently not working on any projects but remain on the job and getting the salary and other perks on time**.

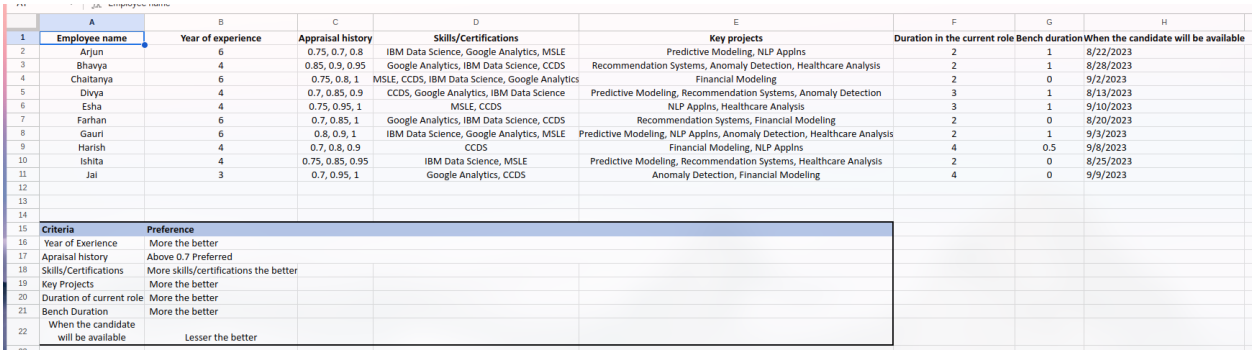
Some employees on bench may also be best suited for the position, as they dont have any current responsibilities and can join immediately.

Appraisal

> 💡 The term “performance appraisal” refers to **the regular review of an employee's job performance and overall contribution to a company**. Also known as an annual review, employee appraisal, performance review or evaluation, a performance appraisal evaluates an employee's skills, achievements, and growth, or lack thereof.

Appraisal is the company’s way of evaluating the employee’s output. Higher the appraisal history of an employee, the more suited they are for the position.

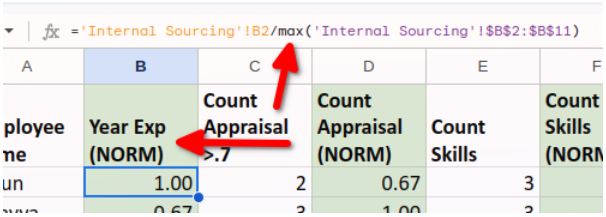
Dataset

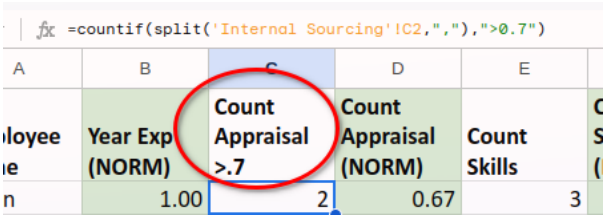


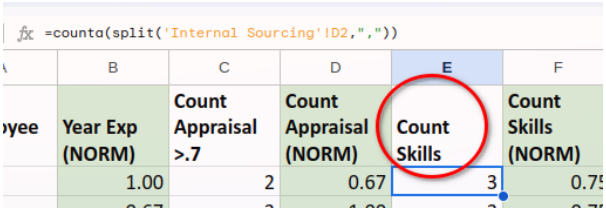
	A	B	C	D	E	F	G	H
1	Employee name	Year of experience	Appraisal history	Skills/Certifications	Key projects	Duration in the current role	Bench duration	When the candidate will be available
2	Arjun	6	0.75, 0.7, 0.8	IBM Data Science, Google Analytics, MSLE	Predictive Modeling, NLP Applns	2	1	8/22/2023
3	Bhavya	4	0.85, 0.9, 0.95	Google Analytics, IBM Data Science, CCDS	Recommendation Systems, Anomaly Detection, Healthcare Analysis	2	1	8/28/2023
4	Chaitanya	6	0.75, 0.8, 1	MSLE, CCDS, IBM Data Science, Google Analytics	Financial Modeling	2	0	9/2/2023
5	Divya	4	0.7, 0.85, 0.9	CCDS, Google Analytics, IBM Data Science	Predictive Modeling, Recommendation Systems, Anomaly Detection	3	1	8/13/2023
6	Esha	4	0.75, 0.95, 1	MSLE, CCDS	NLP Applns, Healthcare Analysis	3	1	9/10/2023
7	Farhan	6	0.7, 0.85, 1	Google Analytics, IBM Data Science, CCDS	Recommendation Systems, Financial Modeling	2	0	8/20/2023
8	Gauri	6	0.8, 0.9, 1	IBM Data Science, Google Analytics, MSLE	Predictive Modeling, NLP Applns, Anomaly Detection, Healthcare Analysis	2	1	9/3/2023
9	Harish	4	0.7, 0.8, 0.9	CCDS	Financial Modeling, NLP Applns	4	0.5	9/8/2023
10	Ishita	4	0.75, 0.85, 0.95	IBM Data Science, MSLE	Predictive Modeling, Recommendation Systems, Healthcare Analysis	2	0	8/25/2023
11	Jai	3	0.7, 0.95, 1	Google Analytics, CCDS	Anomaly Detection, Financial Modeling	4	0	9/9/2023
12								
13								
14								
15	Criteria	Preference						
16	Year of Exerience	More the better						
17	Apraisal history	Above 0.7 Preferred						
18	Skills/Certifications	More skills/certifications the better						
19	Key Projects	More the better						
20	Duration of current role	More the better						
21	Bench Duration	More the better						
22	When the candidate will be available	Lesser the better						

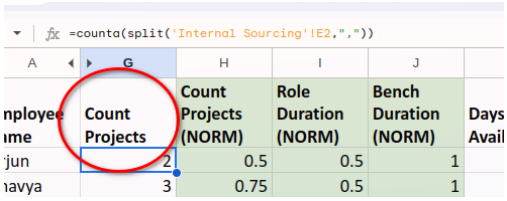
The data is created by the HR team. It is very unstructured and unsanitized. Let us sanitize the data.

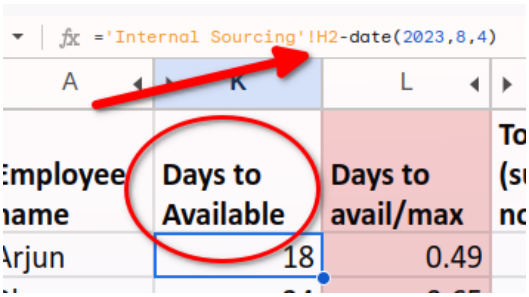
- We can split the appraisal history and skills and key projects into separate columns using the `split()` function of google sheets or the `textsplit()` function of excel. Or we can use the *Text to Columns* feature of excel.
- We can count the number of skills and number of key projects using `counta()` function of excel
- We can count how many appraisals were above 0.7 using `countif()` of excel
- We can find the number of days till availability by subtracting date of avail with current date.
- We can normalize each column by dividing it with the `max()` of the column
- We can add all the positive attributes and subtract the negative attributes (days to avail)
- We can rank the candidates by the final score

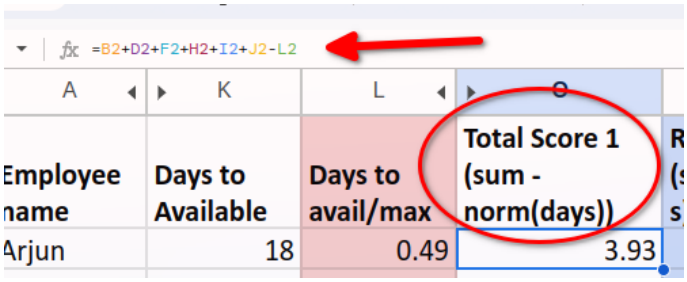






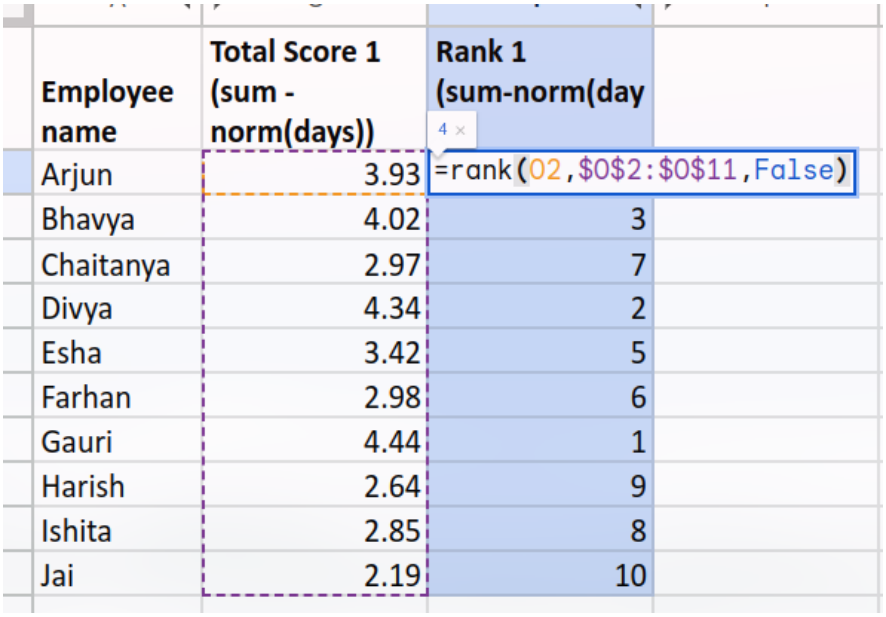






Finally we get the score of the employees.

Now we rank them using the `rank()` function



Finally we get rank of all candidates.

	A	B	C	D	E	F	G	H	I	J	K	L	O	P
1	Employee name	Year Exp (NORM)	Count Appraisal >.7	Count Appraisal (NORM)	Count Skills	Count Skills (NORM)	Count Projects	Count Projects (NORM)	Role Duration (NORM)	Bench Duration (NORM)	Days to Available	Days to avail/max	Total Score 1 (sum - norm(days))	Rank 1 (sum-norm(days))
2	Arjun	1.00	2	0.67	3	0.75	2	0.5	0.5	1	18	0.49	3.93	4
3	Bhavya	0.67	3	1.00	3	0.75	3	0.75	0.5	1	24	0.65	4.02	3
4	Chaitanya	1.00	3	1.00	4	1	1	0.25	0.5	0	29	0.78	2.97	7
5	Divya	0.67	2	0.67	3	0.75	3	0.75	0.75	1	9	0.24	4.34	2
6	Esha	0.67	3	1.00	2	0.5	2	0.5	0.75	1	37	1.00	3.42	5
7	Farhan	1.00	2	0.67	3	0.75	2	0.5	0.5	0	16	0.43	2.98	6
8	Gauri	1.00	3	1.00	3	0.75	4	1	0.5	1	30	0.81	4.44	1
9	Harish	0.67	2	0.67	1	0.25	2	0.5	1	0.5	35	0.95	2.64	9
10	Ishita	0.67	3	1.00	2	0.5	3	0.75	0.5	0	21	0.57	2.85	8
11	Jai	0.50	2	0.67	2	0.5	2	0.5	1	0	36	0.97	2.19	10

Max Normalization

A caution on max normalization. Our only goal is to make sure all data comes in range 0-1. To do that we usually divide the datapoints by the logical upper bound of the data. But some data does not have a logical upper bound like year of experience or days to available etc, so then we divide by max of **Dataset.** But keep in mind that we should still divide by the logical upper bound if it exists.

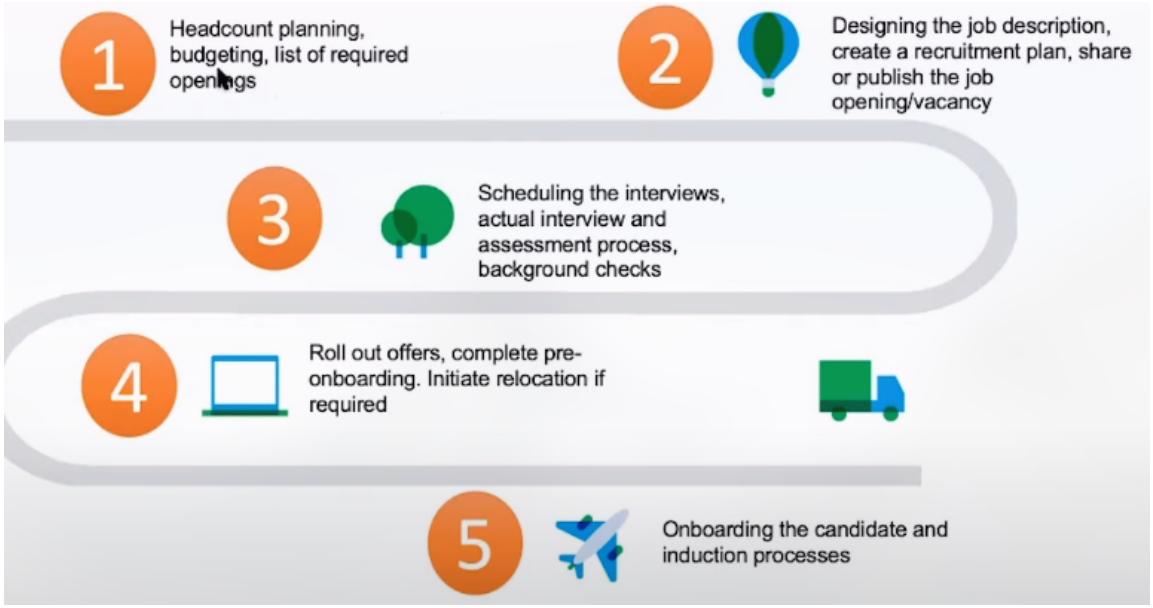
For example, a rating given by a group of people to some restaurants. We can get the average rating received by each restaurant and want to rank them. You may be tempted to normalize the average rating column by dividing each cell by the max of that column, but we should instead divide each cell by `5`. As the logical upper bound of the average rating is 5. Even if no data point goes as high as 5, we still divide by 5.

Case Study 2 - External Sourcing

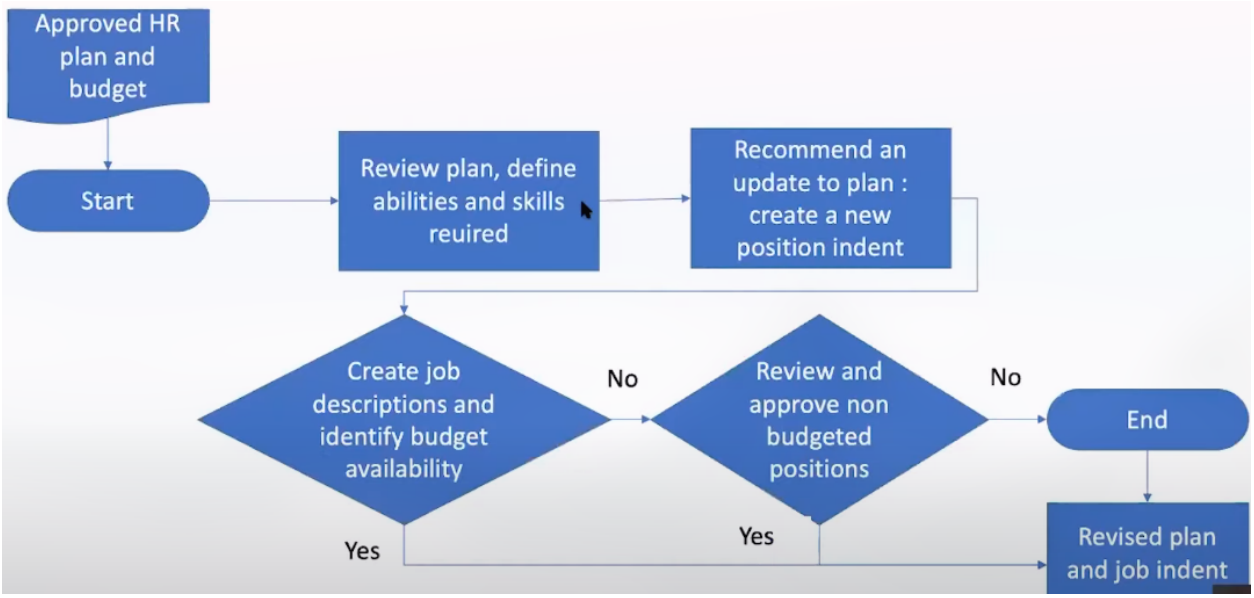
In this dataset we hire people from outside the organization. We list our open position details on multiple **channels** and then hire the applicants who clear the process.

> 💡 A recruitment channel – or recruitment marketing channel – is simply **a source of candidate applications** and may include anything from a job board to a digital marketing platforms, tools or initiatives to attract and convert potential candidates.

To hire people from external source there are a few things to be followed.



HR Planning and Job Indent



Indent or Requisition

> A job requisition is **a formal document or form used to request the creation of a new position or to fill a vacated role**. Managers submit job requisitions to their department and HR team, who then determine if there're enough resources and need for a new hire.

It outlines the

- budgetary details

- timelines of positions to be filled
- whether part-time or full-time or on TPP
- skills required

> 💡 (TPP) Third Party Providers are **organisations or natural persons that use provide service to other companies.**

Job Description (JD)

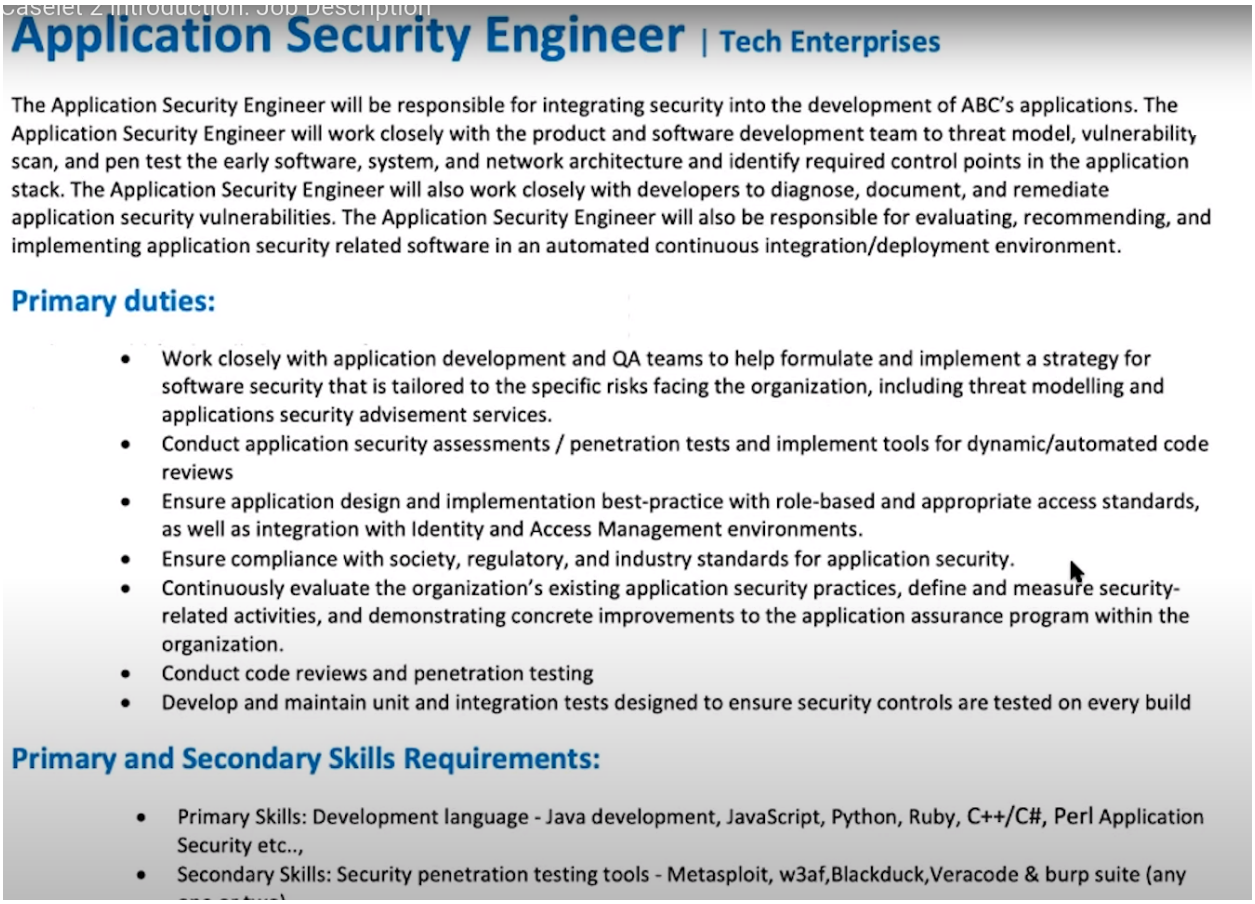
> 💡 Job description refers to a written informative documentation that states the duties, tasks, responsibilities and qualifications of a job, based on the findings of a job analysis. Job description is used either in the recruitment process to inform the applicants of the job profile and requirements or in the performance management process to evaluate the employee's performance.

It is a quick summary of:

- what the role is expected to do
- key responsibilities
- how the performance will be measured
- the skills, capabilities, experience, and educational background required

Sample JD:

Caselet 2 Introduction: Job Description



Application Security Engineer | Tech Enterprises

The Application Security Engineer will be responsible for integrating security into the development of ABC's applications. The Application Security Engineer will work closely with the product and software development team to threat model, vulnerability scan, and pen test the early software, system, and network architecture and identify required control points in the application stack. The Application Security Engineer will also work closely with developers to diagnose, document, and remediate application security vulnerabilities. The Application Security Engineer will also be responsible for evaluating, recommending, and implementing application security related software in an automated continuous integration/deployment environment.

Primary duties:

- Work closely with application development and QA teams to help formulate and implement a strategy for software security that is tailored to the specific risks facing the organization, including threat modelling and applications security advisement services.
- Conduct application security assessments / penetration tests and implement tools for dynamic/automated code reviews
- Ensure application design and implementation best-practice with role-based and appropriate access standards, as well as integration with Identity and Access Management environments.
- Ensure compliance with society, regulatory, and industry standards for application security.
- Continuously evaluate the organization's existing application security practices, define and measure security-related activities, and demonstrating concrete improvements to the application assurance program within the organization.
- Conduct code reviews and penetration testing
- Develop and maintain unit and integration tests designed to ensure security controls are tested on every build

Primary and Secondary Skills Requirements:

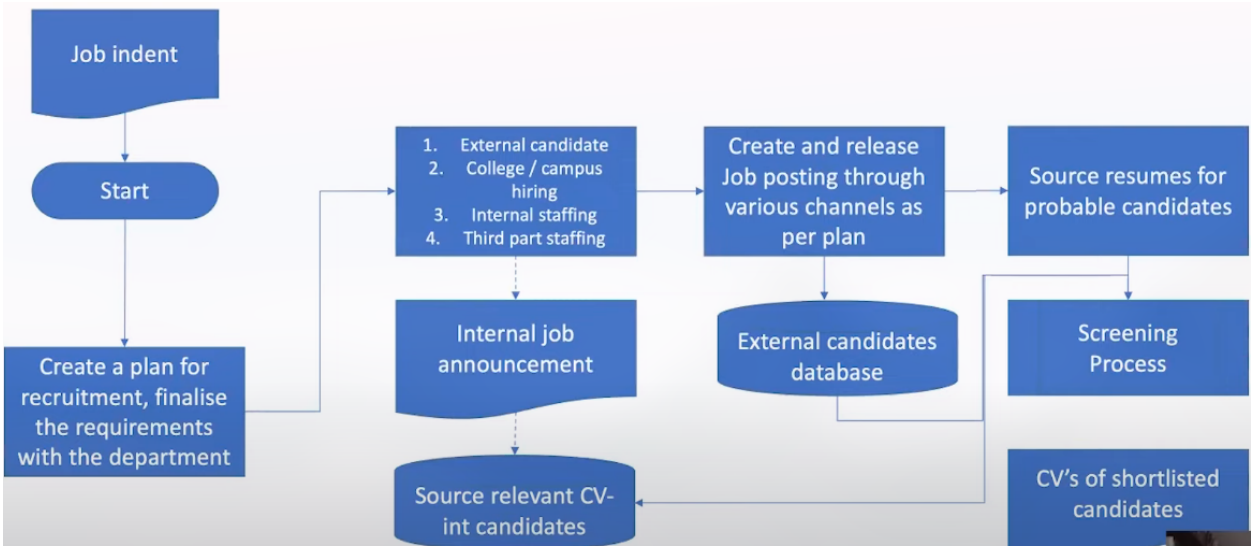
- Primary Skills: Development language - Java development, JavaScript, Python, Ruby, C++/C#, Perl Application Security etc..,
- Secondary Skills: Security penetration testing tools - Metasploit, w3af,Blackduck,Veracode & burp suite (any

Channels

There are four major channels of fullfillment for candidate sourcing.

- Employee referral policy (15-25k bonus for successful referal)
- Social Media like LinkedIn
- Third Party Portal (who take a cut)
- Direct website (company website's job portal)

Sourcing of candidates



Dataset

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Application number	Date of Application	Week	Applicant Name	Employment type	Channel_code	Channel	Position applied for	Primary skill	Certification	Date of Birth	Gender	Nationality	Physically Handicappe
2	A1	1/17/2020	3	Name1	Full Time	2	Employee referral	J1001: Application Security Engineer (developer)	Python,Ruby,C++/C#	GSEC	1989-12-16	Male	INDIAN	
3	A2	1/25/2020	4	Name2	Full Time	2	Employee referral	J1001: Application Security Engineer (developer)	Python,Ruby	GIAC	1988-02-02	Male	Indian	
4	A3	1/18/2020	3	Name3	External	1	Direct website	J1001: Application Security Engineer (developer)	Python,Ruby,C++/C#	CEH	1974-06-18	Male	Indian	
5	A4	1/19/2020	4	Name4	Part Time	2	Employee referral	J1003: Application Security Engineer (Manager)	JavaScript,Python,Ruby	GIAC	1968-04-17	Male	Indian	
6	A5	1/13/2020	3	Name5	External	2	Employee referral	J1001: Application Security Engineer (developer)	JavaScript,Python,Ruby	GSEC	1964-05-30	Male	Indian	
7	A6	1/18/2020	3	Name6	Part Time	2	Employee referral	J1001: Application Security Engineer (developer)	C++/C#,Perl Application Security ,Azure/AWS	GIAC	1987-08-25	Male	indian	
8	A7	1/15/2020	3	Name7	External	1	Direct website	J1001: Application Security Engineer (developer)	JavaScript,Python	0	1975-11-06	Male	Indian	
9	A8	1/23/2020	4	Name8	Part Time	2	Employee referral	J1002: Application Security Engineer (Team Lead)	Python,Ruby	CEH	1975-05-21	Male	Indian	
10	A9	1/18/2020	3	Name9	Part Time	3	Third party	J1001: Application Security Engineer (developer)	C++/C#,Perl Application Security ,Azure/AWS	GSEC	1971-04-21	Male	Indian	
11	A10	1/19/2020	4	Name10	Full Time	2	Employee referral	J1003: Application Security Engineer (Manager)	Ruby,C++/C#	CEH	1989-10-07	Female	Indian	
12	A11	1/18/2020	3	Name11	Full Time	1	Direct website	J1002: Application Security Engineer (Team Lead)	JEE,JavaScript,Python	GSEC	1991-04-06	Male	Indian	
13	A12	1/18/2020	3	Name12	Full Time	3	Third party	J1001: Application Security Engineer (developer)	C++/C#,Perl Application Security	0	1991-05-06	Male	Indian	
14	A13	1/22/2020	4	Name13	Full Time	4	LinkedIn	J1001: Application Security Engineer (developer)	Python,Ruby,C++/C#	GSEC	1988-07-05	Male	Indian	
15	A14	1/18/2020	3	Name14	External	4	LinkedIn	J1001: Application Security Engineer (developer)	JEE,JavaScript,Python	0	1981-05-10	Male	INDIAN	
16	A15	1/22/2020	4	Name15	Full Time	2	Employee referral	J1001: Application Security Engineer (developer)	JavaScript,Python,Ruby	GSEC	1992-09-19	Male	indian	
17	A16	1/18/2020	3	Name16	Part Time	3	Third party	J1003: Application Security Engineer (Manager)	Python,Ruby,C++/C#	GIAC	1976-07-13	Male	Indian	
18	A17	1/12/2020	3	Name17	Part Time	2	Employee referral	J1001: Application Security Engineer (developer)	C++/C#,Perl Application Security ,Azure/AWS	CEH	1981-10-02	Male	indian	
19	A18	1/24/2020	4	Name18	Part Time	4	LinkedIn	J1002: Application Security Engineer (Team Lead)	Azure/AWS,Git	GSEC	1982-11-01	Male	Indian	
20	A19	1/11/2020	2	Name19	External	2	Employee referral	J1001: Application Security Engineer (developer)	C++/C#,Perl Application Security	GSEC	1982-07-15	Male	INDIAN	
21	A20	1/22/2020	4	Name20	External	2	Employee referral	J1001: Application Security Engineer (developer)	Python,Ruby	0	1969-05-20	Male	Indian	

	AG	AH	AI
	of rk Applicants feedback on Ease of application	Shortlisted	Selection_decision
	4	Yes	Yes
	3	Yes	No
	3	Yes	No
	3	Yes	No
	4	Yes	No
	2	No	No
	4	No	No
		No	No
	1	Yes	Yes
	1	Yes	No
	5	Yes	No
	4	Yes	No
		Yes	No

The dataset has many columns (35), they are:

Application number	Channel_code	Date of Birth	Work Exp.	UG Univ Rank	PG Degree	PG Total Marks
Date of Application	Channel	Gender	UG Mode	UG Percentile/CGPA	PG Discipline	PG Out of Total Mark
Week	Position applied for	Nationality	UG Degree	UG Total Marks	PG YOG	Applicants feedback on Ease of application
Applicant Name	Primary skiil	Physically Handicapped	UG Discipline	UG Out of Total Mark	PG Univ Rank	**Shortlisted**
Employment type	Certification	Marital Status	UG YOG	PG Mode	PG Percentile/CGPA	**Selection decision**

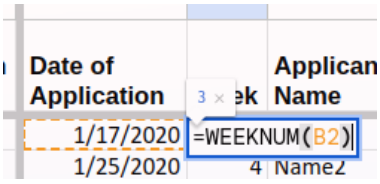
Our work here is to find out which channels are effective and which channels are not.

We do this by creating a few pivot tables to generate useful insights and then using them to give a score to each channel, and finally rank them.

- We pivot around channels and count the percentage of applications through each

	A	B
1	*Channel*	COUNTA of Application number
2	Direct website	20.37%
3	Employee referral	20.10%
4	LinkedIn	21.41%
5	Third party	38.12%
6	**Grand Total**	**100.00%**

- We calculate the week of each application using the `weeknum()` function of excel



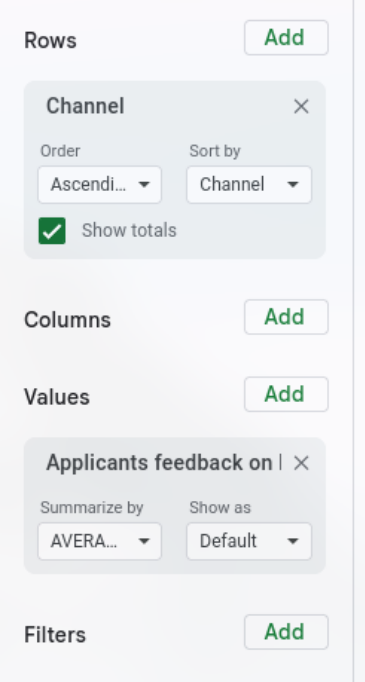
Then we pivot around channels and weeknum to get the weekly flow of application through each channel, we then take the average or max flow for each channel andnormalize it.

8	*COUNTA of Applica*	*Week*							
9	*Channel*	1	2	3	4	5	Grand Total	Max Weekly Flo	Normalized Max Week Flow
10	Direct website		8	50	8	12	78	50	**0.83**
11	Employee referral	10	10	22	23	12	77	23	**0.38**
12	LinkedIn	2	15	25	27	13	82	27	**0.45**
13	Third party		33	60	44	9	146	60	**1.00**
14	**Grand Total**	**12**	**66**	**157**	**102**	**46**	**383**		
15									

- We pivot around channels and shortlisted to see what percentage of applications are shortlisted for each channel

COUNTA of Applica	Shortlisted			
Channel	No	Yes	Grand Total	PERC shortlisted
Direct website	29	49	78	**0.63**
Employee referral	34	43	77	**0.56**
LinkedIn	38	44	82	**0.54**
Third party	46	100	146	**0.68**
Grand Total	**147**	**236**	**383**	0.62

- We also have the apllicant's review of the channel where higher is better, so we take the average review of each channel by pivoting around channels and taking AVG of rating values and normalize them by dividing it by 5 (the upper bound)



Channel	AVERAGE of Ap	AVG / 5
Direct website	2.71	**0.54**
Employee referral	3.01	**0.60**
LinkedIn	2.76	**0.55**
Third party	2.71	**0.54**
Grand Total	**2.783382789**	

Finally we sum all the normalized values and get a grand score, on which we rank the channels

	COUNTA of Application number	Normalized Max Week Flow	PERC shortlisted	AVG / 5	Score = sum(metrics)	Rank
Direct website	0.20	0.83	0.63	0.54	**2.21**	2
Employee referral	0.20	0.38	0.56	0.60	**1.75**	4
LinkedIn	0.21	0.45	0.54	0.55	**1.75**	3
Third party	0.38	1.00	0.68	0.54	**2.61**	1

Descriptive Statistics

We can also find some statistics by using `countif` and `countifs` or pivot tables. We can take unique rows by using `unique` function.

Gender	No of Application
Male	276
Female	107
	383

Certification	No of Application
GSEC	131
GIAC	69
CEH	118
0	65
	383

Gender	Certification	No of Applications
Male	GSEC	92
Male	GIAC	51
Female	GSEC	39
Female	CEH	36

Count of Application number	Column Labels			
Row Labels	**No**	**Yes**	**Grand Total**	
Female	101	6	107	6%
Male	255	21	276	8%
Grand Total	**356**	**27**	**383**	

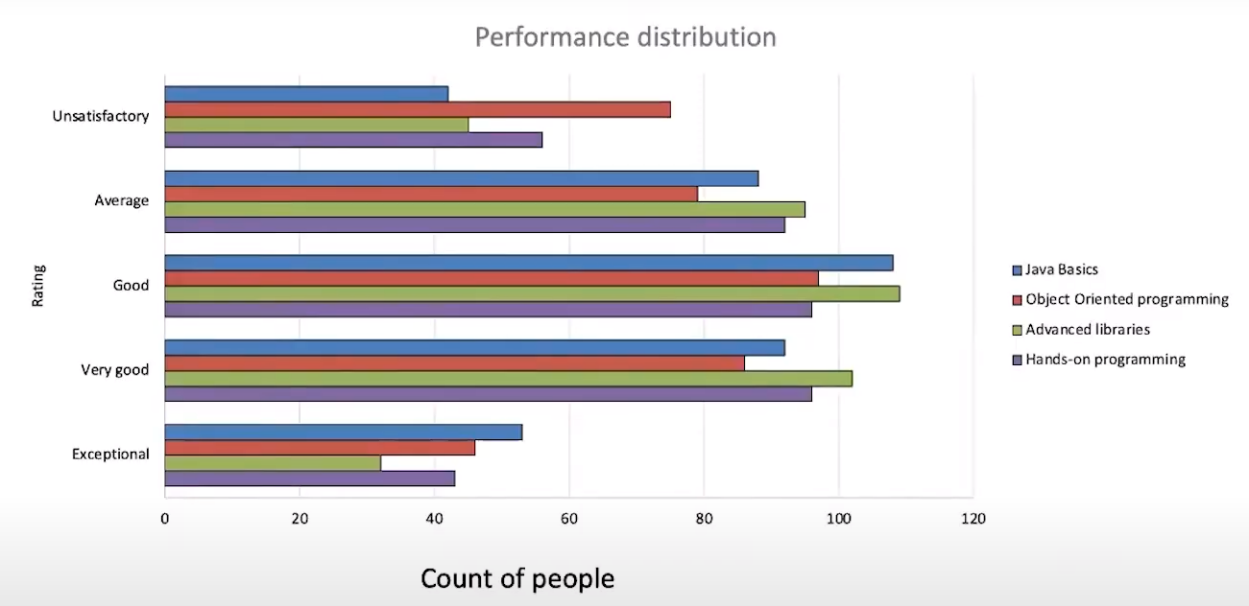
	Row Labels	Count of Application number
10	CEH	118
11	GIAC	69
12	GSEC	131
13	**Grand Total**	**318**

Row Labels	Count of Application number
Female	**107**
0	14
CEH	36
GIAC	18
GSEC	39
Male	**276**
0	51
CEH	82
GIAC	51
GSEC	92
Grand Total	**383**

	Count of Application number	Column Labels		
4	**Row Labels**	**No**	**Yes**	**Grand Total**
5	J1001: Application Security Engineer (developer)	215	23	238
6	J1002: Application Security Engineer (Team Lead)	57	1	58
7	J1003: Application Security Engineer (Manager)	84	3	87
8	**Grand Total**	**356**	**27**	**383**

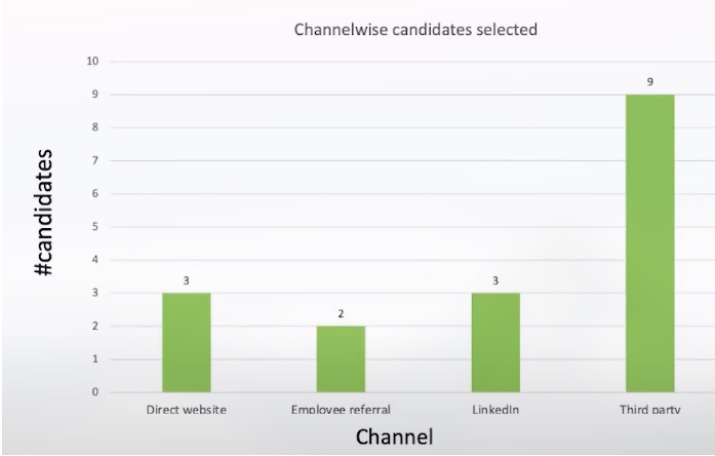
	Count of Application number	Column Labels				
11	**Row Labels**	**Direct website**	**Employee referral**	**LinkedIn**	**Third party**	**Grand Total**
12	J1001: Application Security Engineer (developer)	49	53	48	88	238
13	J1002: Application Security Engineer (Team Lead)	17	6	12	23	58
14	J1003: Application Security Engineer (Manager)	12	18	22	35	87
15	**Grand Total**	**78**	**77**	**82**	**146**	**383**

Charts

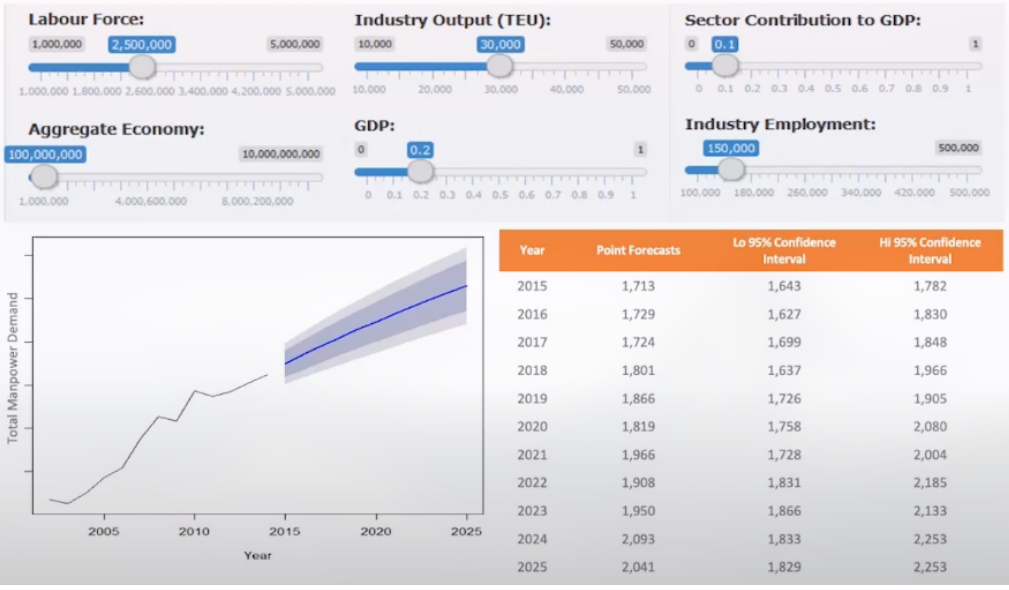


This follows a normal distribution bell curve.

> **Bell Curve:** a graph of a normal (Gaussian) distribution, with a large rounded peak tapering away at each end.



Role of HR

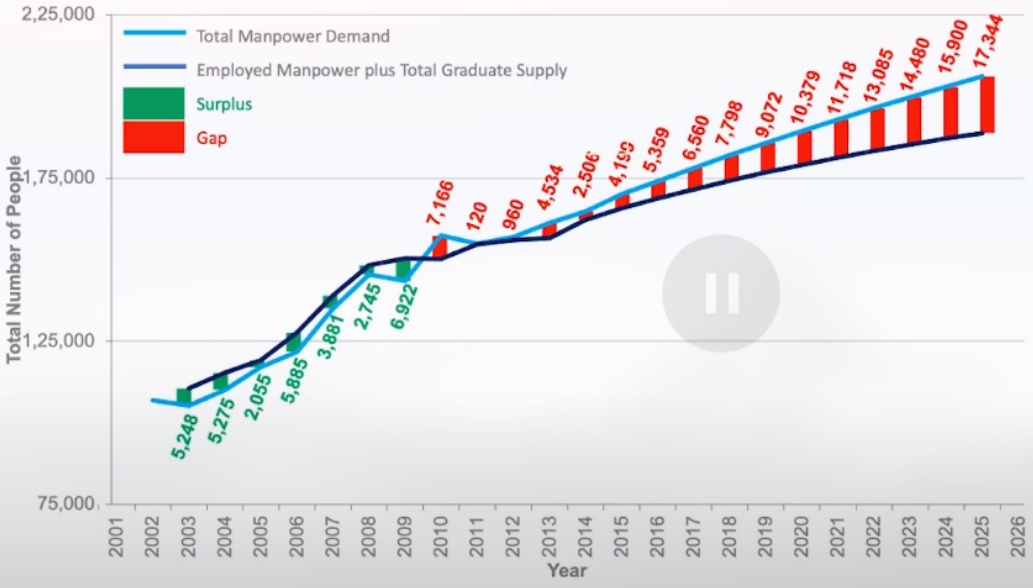


Year	Point Forecasts	Lo 95% Confidence Interval	Hi 95% Confidence Interval
2015	1,713	1,643	1,782
2016	1,729	1,627	1,830
2017	1,724	1,699	1,848
2018	1,801	1,637	1,966
2019	1,866	1,726	1,905
2020	1,819	1,758	2,080
2021	1,966	1,728	2,004
2022	1,908	1,831	2,185
2023	1,950	1,866	2,133
2024	2,093	1,833	2,253
2025	2,041	1,829	2,253

Six to eight factors considered for creating a workforce model and estimating demand

Used for generating various scenarios to determine demand-supply gaps

Workforce forecast model – Scenarios for identification of supply gaps



Finance and Fintech

Tags	BNPL Credit Fintech Money Flow Nudge Economics Risk Analysis
Course	BDM
# Week	10
Created time	@August 26, 2023 2:59 PM

Finance and Fintech

FinTech, an amalgamation of "financial technology," refers to the application of technology to enhance and innovate various aspects of financial services. It entails the utilization of software, algorithms, and digital platforms to streamline, automate, and improve financial activities and processes. The objective of FinTech companies is to **address inefficiencies, reduce friction, and enhance accessibility** within the realm of financial services.

Finance originally was Banks and Credit Merchants like Visa and MasterCard. Then we had online payment facilitators and aggregators like PayPal, PayTM, Razorpay, etc. Now we also have platform who themselves finance your payment by providing **short term low volume loans.** These are done by **NBFC (Non Banking Financial Companies)** and are called **BNPL (Buy Now Pay Later).**

1. **Buy Now, Pay Later (BNPL):**
   Buy Now, Pay Later (BNPL) is a contemporary financial arrangement that enables consumers to make purchases immediately and defer payment to a later date. Unlike traditional credit models, BNPL does not involve the accrual of interest over time. Instead, it offers a deferred payment schedule, often divided into installments. This mechanism provides consumers with more flexible purchasing options and budget management, while merchants benefit from increased sales volume and customer engagement.

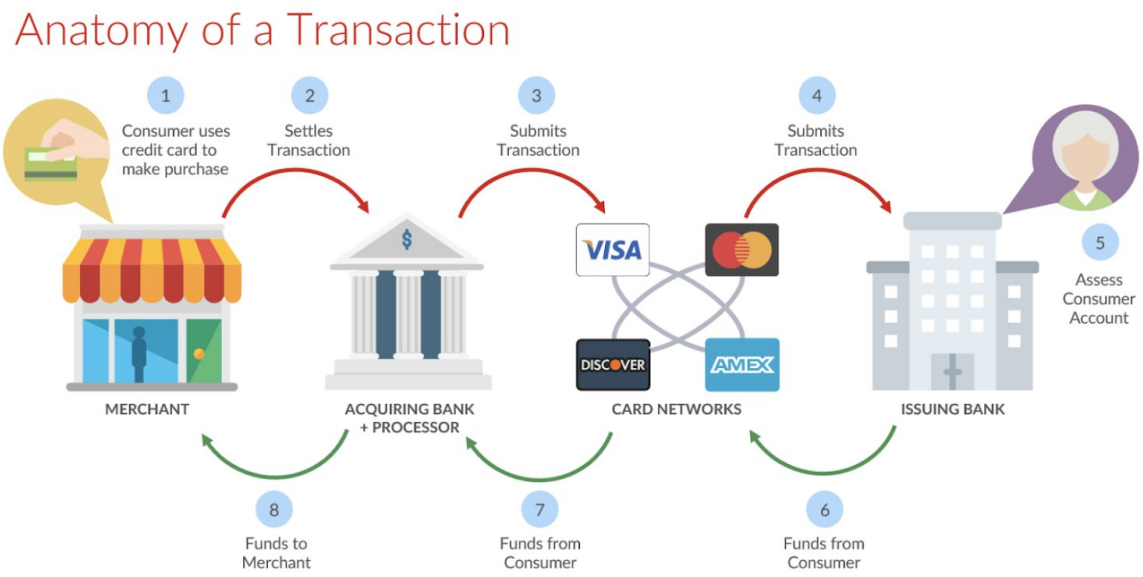
2. **Pay Later:**
   Pay Later is a financial concept that permits consumers to postpone immediate payment for goods or services, allowing them to obtain the desired item without an upfront monetary transaction. This method typically involves an agreement where the consumer commits to settling the payment in the future, often in multiple installments. It's important to note that while Pay Later may share similarities with credit or loan arrangements, it doesn't always involve interest charges or a stringent credit check.
3. **Credit:**
   Credit refers to the financial trust extended by a lender to a borrower, allowing the borrower to access funds or goods with the commitment to repay the borrowed amount, often with added interest, at a later date. Credit arrangements can take various forms, such as credit cards, lines of credit, and loans. These arrangements are often subject to credit checks and assessments of the borrower's financial history to determine the borrower's creditworthiness and the terms of the credit agreement.

Reduction of Friction

Due to the one click payments of BNPL and Pay Later and how the user does not have to worry about financing his whim immediately, it reduces the metaphorical friction of making the transaction. This increases business for the platform as more people are spending money which they have to pay back in some time.

Flow of Money in payment facilitators

When a transaction is made, the money has to travel from the user (bank balance or credit) to the merchant. This seems simple on paper but is very complicated in practise due to multiple methods of payment existing and multiple platforms have multiple protocols. In general it is done as follows:



1. The user's details are validated by user's bank
    a. correct credentials
    b. sufficient balance or credit
2. The transaction is sent to the payment facilitator like Visa or Mastercard
3. The facilitator sends the transaction to the merchant's bank
4. The bank reflects credit of the amount

This is how a credit card transaction works. For UPI the process is a little different as there are not multiple providers but only one centralized provider and protocol.

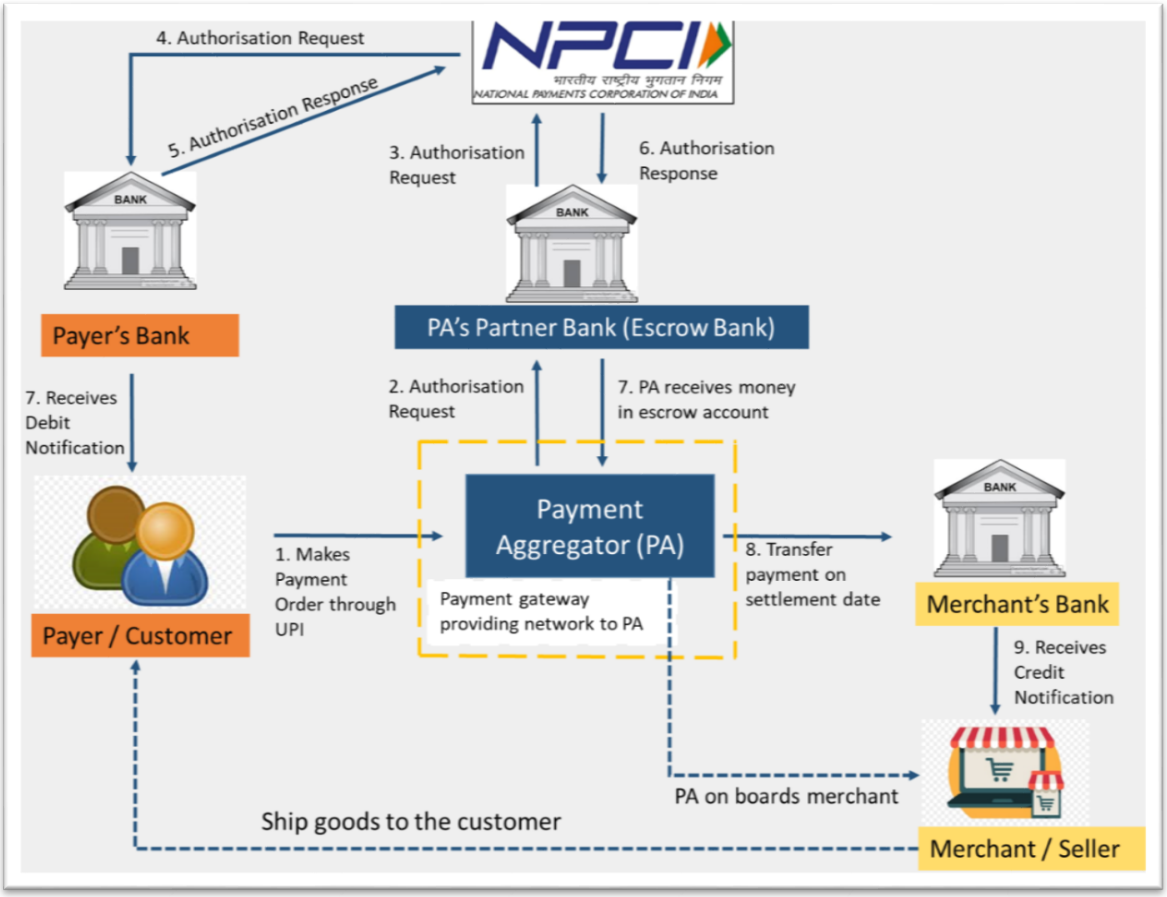


Fig 1: End to end non-bank payment aggregator transactional flow
The blue dotted lines in the fig. do not form part of payment system, but forms an important part of legal basis in merchant on-boarding process and shipment of goods to the customers in a PA business model.
Source: Author

Nudge Economics

Nudge theory is a concept in behavioral economics that proposes **adaptive designs of the decision environment** (choice architecture) as ways to influence the behavior and decision-making of groups or individuals. Nudging contrasts with other ways to achieve compliance, such as education, legislation or enforcement.

For example, when you open amazon or flipkart and certain products are **recommended** to you based on your profile and that of people like you, the platform tries to give you a suggestion of what to buy.

Another example: most websites ask if you want to enable or disable cookies but the default option is set to enable all cookies, this works because people in general are lazy and will select the default option.

The **nudge** concept was popularized in the 2008 book *Nudge: Improving Decisions About Health, Wealth, and Happiness*, by behavioral economist Richard Thaler

What is a nudge?

> A nudge is *any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not.*

Perhaps the most frequently mentioned nudge is the setting of defaults, which are pre-set courses of action that take effect if nothing is specified by the decision-maker. This type of nudge, which works with a human tendency for inaction, appears to be particularly successful, as people may stick with a choice for many years

How it is relevant in fintech?

We have multiple payment options, UPI, debit cards (multiple, with varying offers), credit cards (with varying amount of credits), Buy Now Pay Later (BNPL), etc.

We need to select a default with makes most sense for the customer. This is where nudge economics comes into play.

30-40% of people go to cart and then stop doing the transaction, this is called transaction drop. To prevent this each step of the process should be unambiguous, clear, and have sane defaults.

Marketing vs Credit Risk

The marketting division of a BNPL wants to market the product to more and more customers so that the revenue increases. This is their primary goal, which is to increase the number of people who hear about the product and use it. On the other hand, the Credit Risk team would want to make sure only people who are promising of repaying the loan get the credit option. This shows a minimization-maximization dilemma. On one hand the marketting team wants everyone to try the feature out, but on the other hand the credit risk team wants the company to not lose money. To balance this out a credit score is assigned to every prospective customer and their credit balance is set according to the score. The more likely a person is to repay their loan, the bigger loan they qualify for.

Transaction Dataset

Having a dataset on transaction allows us to see which customer, which platform, and which payment option are used, and their corresponding value.

Cust ID	Trans ID	Timestamp	Merchant Segment	Device	Funding Instrument	Price
17289	A17F354C	2021-03-17 12:41:33	Fashion	Mobile	PayBuddy_Pay_Later	117
17290	E3C4A3B0	2021-04-24 09:59:12	Pantry	Mobile	PayBuddy_Pay_Later	288
17291	B61FFCD8	2021-06-06 17:06:29	Fashion	Mobile	PayBuddy_Pay_Later	163
17292	86B2F999	2021-05-07 00:43:51	Website-serv	Mobile	Netbanking	336
17293	27FF4544	2021-04-13 17:49:29	Electronics	Web	Wallet	663
17294	9603FED8	2021-05-17 23:31:32	Travel	Web	Debit_Card	3899
17295	29DEEDFE	2021-06-05 20:59:23	Pantry	Web	Netbanking	264
17296	DD2AA216	2021-03-25 11:46:33	Website-serv	Web	PayBuddy_Pay_Later	771
17297	99860BB7	2021-03-27 15:21:20	Travel	POS	PayBuddy_Cobrand_Card	2015
17298	9D2BF751	2021-03-22 16:38:31	Travel	Web	PayBuddy_Credit_Card	1678
17299	67868B53	2021-03-17 16:12:45	Fashion	Mobile	PayBuddy_Pay_Later	136
17300	5EA247C1	2021-04-22 01:37:36	Travel	Web	Wallet	903
17301	C3C16ACD	2021-04-17 19:56:02	Travel	Mobile	PayBuddy_Pay_Later	966
17302	72334C68	2021-05-04 03:05:06	Pantry	Web	Wallet	271

Transaction Details | Customer Details | Merged Data | 1.1 - Marketing Data | 1.2 Marketing Prediction | 1.3 Marketing AB Testing | 1.4 Marketing Analysis | Sheet7 | 2.1 Credit Risk

- Customer ID → uniquely identifies the customer (can be repeated as one can make multiple transactions)
- Time
- Merchant Segment → can be used to find similarities in certain categories of purchases
- Device → where the transaction took place, Mobile, Web, or POS (Point of Sale → in store)
- Instrument →which payment option was used
- Price

Customer Dataset

Cust ID	ZipCode	Account_age	Sum_12_mn	Sum_12_mn	Pcnt_debit_c	Num_premiu	Eng_segment
17289	24132	18	542	25741	92	2	About_to_churn
17290	65749	13	1115	18137	96	1	About_to_churn
17291	29978	6	1676	26719	88	1	Medium
17292	20237	5	2869	18268	56	1	High
17293	43077	6	7275	9693	67	0	Medium
17294	55507	20	1614	16270	56	2	Medium
17295	30476	1	4998	19341	57	3	Medium
17296	40310	10	1627	26999	98	2	Medium
17297	30771	36	4860	1841	15	8	Low
17298	58117	51	20052	2453	16	4	Medium
17299	60411	18	949	24387	76	1	About_to_churn
17300	26436	17	1427	11912	66	0	Medium
17301	41208	19	737	22705	89	1	Medium
17302	74975	15	5172	10890	63	1	Medium
17303	71216	14	1594	10971	43	3	Medium
17304	25449	12	1893	12174	62	2	About_to_churn

- Customer ID → unqiuely identifies a customer. unqiue.
- Zip Code (Location) [NOTE: should not use location to decide credit, as it is discrimination]
- Age of account → duration of being with platform
- Sum of credit transactions → total of transactions done using credit in one year
- Sum of debit transactions → total of transactions done using debit in one year
- Percentage of Debit Cards in Wallet → the ratio of debit cards to all cards in wallet
- Number of Premium Cards in Wallet → more premium cards mean more credit worthy
- Engagement → How often the customer uses the platform (about to churn means about to leave the platform)

From these two datasets we have to figure out which customers are more likely to use BNPL (and thus whom to recommend BNPL as a default to). This is also called A/B Testing.

User Analysis

As W10L6, we analyze what kind of people use which mode of payment (DC, Netbanking, CC, Cobrand Card, BNPL). We see the aggregate statistics of these users on the variables of age of account (avg, min, max), avg of sum of amount spent on credit card, debit card, average of percentage of debit cards in wallet, and average of count of premium cards.

Values	Column La Debit_Card	Netbanking	PayBuddy_Cobrand_Card	PayBuddy_Credit_Card	PayBuddy_Pay_Later	Wallet	(blank)	Grand Total
Min. of Account_age_months	1	1	18	32	2	5		1
Average of Account_age_months	13	8	30	45	11	12		18
Max. of Account_age_months	24	15	42	60	20	18		60
Average of Sum_12_mnth_credit_txn	1,698	3,713	17,524	22,965	998	4,214		6,746
Average of Sum_12_mnth_debit_txn	17,134	13,736	2,589	2,719	21,002	10,396		13,777
Average of Pcnt_debit_cards_in_wallet	68	52	14	17	87	60		59
Average of Num_premium_cards	2	2	6	4	2	1		2

This shows us that users of credit card and cobrand card are:

- more account age than debit card users
- more spend on credit card than debit card
- Lower percentage of DC in wallet
- Higher count of premium cards

We see that BNPL users are more leaning towards DC and NB users than CC users, thus BNPL is used in addition to and instead of DC, but it cannot replace CC users.

Category Analysis

We see that which type of transaction has how many usage of which mode of payment.

Count of Trans ID	Column Labels						
Row Labels	Debit_Card	Netbanking	PayBuddy_Col	PayBuddy	PayBuddy_P	Wallet	Grand Total
Electronics	89	119	14	26	140	95	483
Fashion		86			944	90	1120
Others	29	11	13	52	3	4	112
Pantry		87			332	73	492
Travel	394	172	345	752	31	29	1723
Website-services	148	287			359	275	1069
Grand Total	**660**	**762**	**372**	**830**	**1809**	**566**	**4999**

It is clear that people doing travel transaction do not prefer BNPL, but electronics and fashion and pantry transactions highly prefer BNPL. Whereas travel transactions are predominantly done using credit cards.

Device Analysis

We see which mode of payment is prefered for each device (web or mobile or POS).

Count of Trans ID	Column Labels						
Row Labels	Debit_Card	Netbanking	PayBuddy_Col	PayBuddy_Cred	PayBuddy_Pay_	Wallet	Grand Total
Mobile	161	206	70	428	1363		2228
POS			220				220
Web	499	556	82	402	446	566	2551
Grand Total	**660**	**762**	**372**	**830**	**1809**	**566**	**4999**

It is clear that POS can only be done through PayBuddy if they are using PayBuddy card, no other card transaction details will be available with PayBuddy for POS.

It is also clear that mobile users prefer BNPL way more than Web users.

Web users prefer net banking and debit card (this can be justified as a corellation and not causation, as older people prefer web over mobile and they also prefer NB and DC over CC and BNPL).

Also phone purchases can be more of ‘impulse’ purchases thus using BNPL.

Engagement Analysis

We see which mode of payment is prefered for each type of engagement of customer.

Count of Trans ID	Column Labels						
Row Labels	Debit_Card	Netbanking	PayBuddy_Cobrand_Card	PayBuddy_Credit_Card	PayBuddy_Pay_Later	Wallet	Grand Total
About_to_churn	100	131	64		563	93	951
High	93	125	81	436		89	824
Low	117	126	66		625	88	1022
Medium	350	380	161	394	621	296	2202
Grand Total	**660**	**762**	**372**	**830**	**1809**	**566**	**4999**

It is clear that high engagement users prefer credit card very highly.

Users about to leave platform are mostly using BNPL. It may be that they abandon the platform, or that BNPL is the only straw holding them back.

Low engagement users are also using BNPL predominantly.

Medium engagement users are fairly split between all modes.

Price of Each Category

Merchant Industry vs Price	
Row Labels	**Average of Price**
Travel	2,878.4
Others	2,799.2
Electronics	645.5
Website-services	543.0
Pantry	205.5
Fashion	148.6
(blank)	
Grand Total	**1,286.8**

The most expensive category is travel, and that is solely done using credit card.

Reasons could be:

1. Travels are mostly done after having a seniority in life, who usually hold and use credit cards (in USA)

2. Travel purchases being high value are not suitable for BNPL, credit card is more suited. (BNPL has upper limit of 600$)
3. Travel like flight booking via credit card gives points which BNPL does not.

Merchant Industry vs FI Count	
Row Labels	Count of Func
Travel	**0.34**
Debit_Card	0.23
Netbanking	0.10
PayBuddy_Cobrand_Card	0.20
PayBuddy_Credit_Card	0.44
PayBuddy_Pay_Later	0.02
Wallet	0.02
Fashion	**0.22**
Netbanking	0.08
PayBuddy_Pay_Later	0.84
Wallet	0.08
Website-services	**0.21**
Debit_Card	0.14
Netbanking	0.27
PayBuddy_Pay_Later	0.34
Wallet	0.26

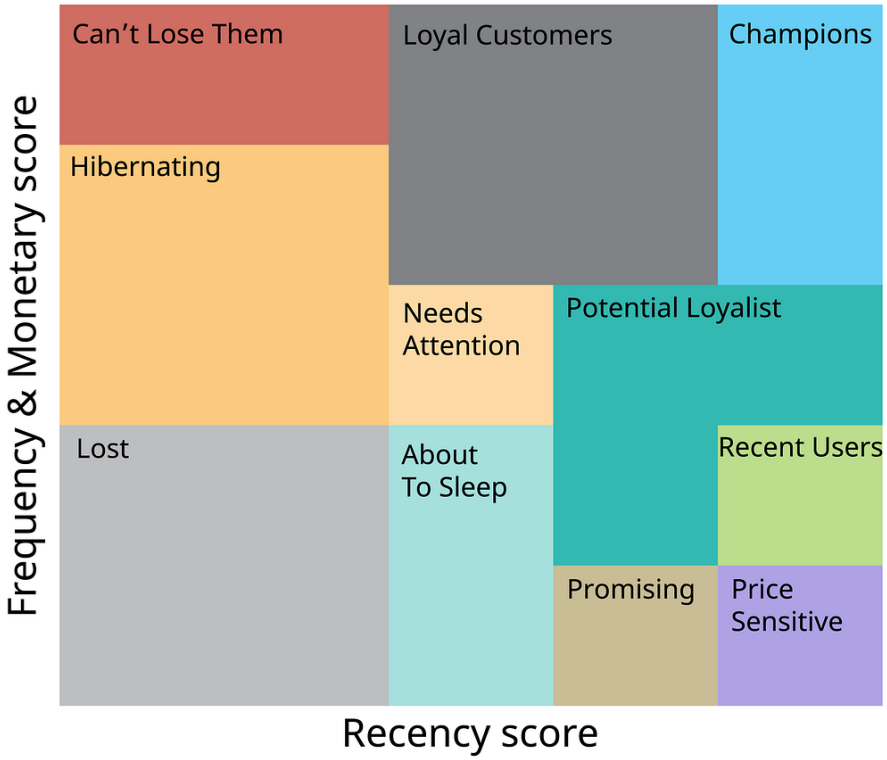
64% of travel purchases are done using credit card or cobrand card.

RFM Analysis

Recency, frequency, monetary value (RFM) is a model used in marketing analysis that segments a company's consumer base by their purchasing patterns or habits. In particular, it evaluates customers' recency (how long ago they made a purchase), frequency (how often they make purchases), and monetary value (how much money they spend).

RFM is then used to identify a company's or an organization's best customers by measuring and analyzing spending habits to improve low-scoring customers and maintain high-scoring ones.

Predictive Segments (RFM)



A/B Testing and Credit Risk

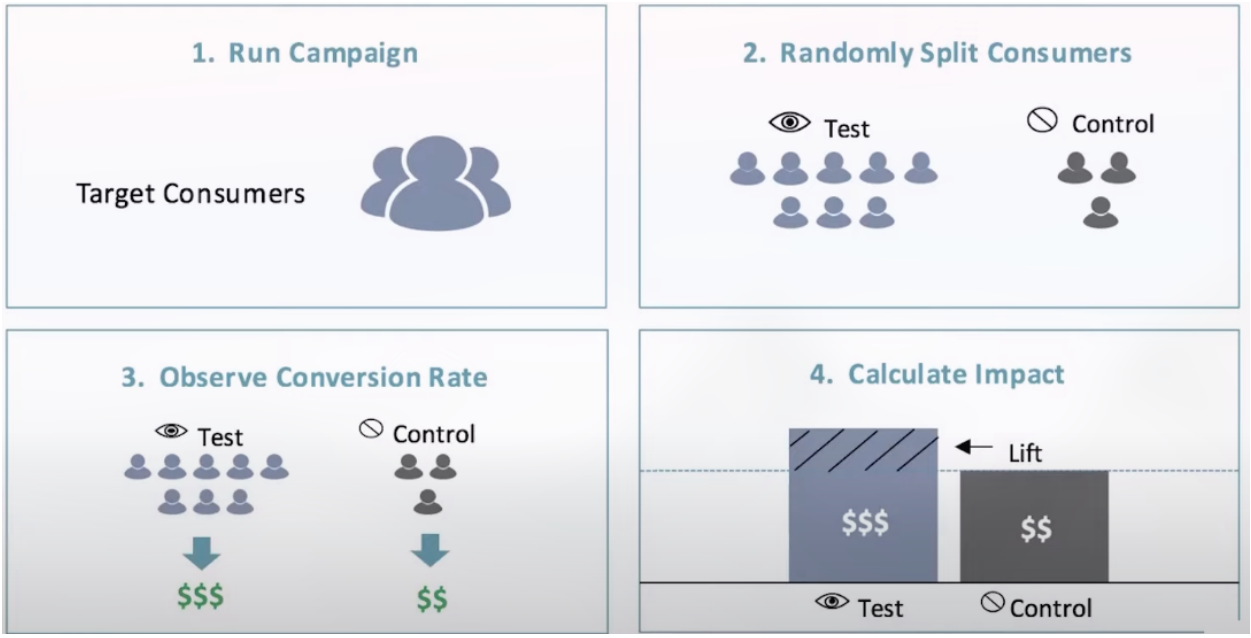
Tags	A/B Testing Credit Risk
Course	BDM
# Week	11
Created time	@August 26, 2023 5:32 PM

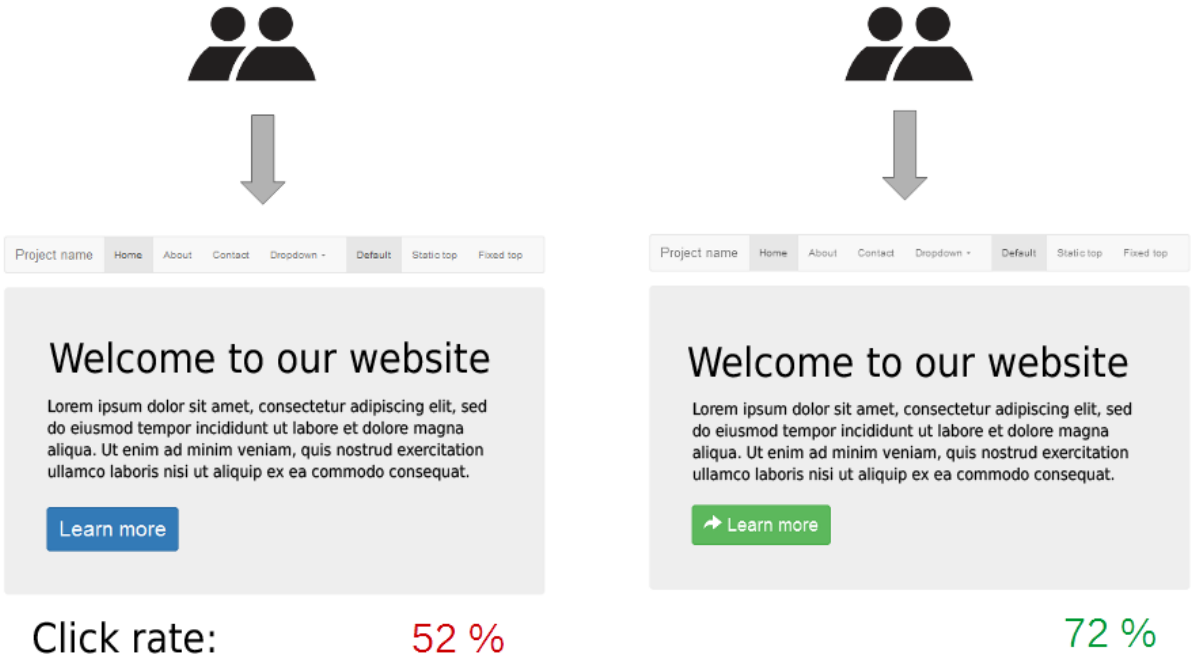
A/B Testing

Alpha Beta Testing also known as A/B Testing.

A/B testing (also known as **bucket testing**, **split-run testing**, or **split testing**) is a user experience research methodology. A/B tests consist of a randomized experiment that usually involves two variants (A and B), although the concept can be also extended to multiple variants of the same variable. It includes application of statistical hypothesis testing or "two-sample hypothesis testing" as used in the field of statistics. A/B testing is a way to compare multiple versions of a single variable, for example by testing a subject's response to variant A against variant B, and determining which of the variants is more effective.

We can keep one variant as the base or control and another as a new feature to see how much it performs compared to the base case.





Common test statistics

"Two-sample hypothesis tests" are appropriate for comparing the two samples where the samples are divided by the two control cases in the experiment. Z-tests are appropriate for comparing means under stringent conditions regarding normality and a known standard deviation. Student's t-tests are appropriate for comparing means under

relaxed conditions when less is assumed. Welch's t test assumes the least and is therefore the most commonly used test in a two-sample hypothesis test where the mean of a metric is to be optimized. While the mean of the variable to be optimized is the most common choice of estimator, others are regularly used.

For a comparison of two binomial distributions such as a click-through rate one would use Fisher's exact test.

Assumed distribution	Example case	Standard test	Alternative test
Gaussian	Average revenue per user	Welch's t-test (Unpaired t-test)	Student's t-test
Binomial	Click-through rate	Fisher's exact test	Barnard's test
Poisson	Transactions per paying user	E-test	C-test
Multinomial	Number of each product purchased	Chi-squared test	G-test
Unknown		Mann–Whitney U test	Gibbs sampling

In A/B Testing only ONE variable must change and everything else must remain same.

A/B Testing Experiment

Dataset

Sum_3_mnth_debit_txn	Pcnt_debit_cards_in_wallet	Num_premium_cards	Old_eng_segment	New_eng_segment	Group
4576	98	2	About_to_churn	Medium	T
2788	50	0	Medium	Medium	C
7470	78	2	Medium	High	C
1109	13	5	High	High	T
1093	20	4	Medium	Medium	T
435	20	4	High	High	T
3250	76	2	About_to_churn	High	C
3460	53	1	About_to_churn	High	C
629	17	6	High	Medium	C
504	21	5	High	Medium	T
2882	56	1	Medium	High	C
597	13	7	Medium	High	T
625	12	3	Medium	High	T
2929	67	1	Low	Low	T
2558	67	0	Low	High	T
298	12	6	High	High	C

Here we have a new dataset like the original one, where we have data about customers, but also three additional columns, namely

- Old engagement
- New engagement
- Test Group (T for test or C for control)

To see this experiment was successful we need to see two things

1. The grouping was good (The sample was representative of the entire population)
2. The T group shows signifcant growth compared to C group.

1. Representative Sampling

Row Labels	Average of Sum_3_mnth_credit_txn	Average of Sum_3_mnth_debit_txn
C	1724.81	3460.19
T	1798.66	3339.34
Grand Total	**1774.40**	**3379.04**

We can see that if we compare the average debit and credit spends of the groups, they are almost equal, so the grouping is not biased.

2. Show growth:

Count of Trans ID	Column Labels			
Row Labels	High	Low	Medium	Grand Total
About_to_churn	511		513	1024
High	550		276	826
Low	489	231	234	954
Medium	1471		724	2195
Grand Total	**3021**	**231**	**1747**	**4999**

We can see that all about_to_churn have become high or medium engagement, almost all low have converted to high or medium, and almost all medium has moved up to high. Only downfall is some high people became medium.

But this growth is the total growth and which may not be due to the experiment at all, now lets compare the T and C groups.

Test Group	High	Low	Medium
About to Churn	59%	0	41%
High	73%	0	27%
Low	60%	16%	24%
Medium	73%	0	27%
Control Group	High	Low	Medium
About to Churn	32%	0	68%
High	48%	0	52%
Low	23%	53%	24%
Medium	51%	0	49%

If we separately see Test and Control group it is very clear that test group consistently pushed all strata to the ones above as compared to the control group which proves that the experiment was successful.

Credit Risk

What is credit risk?

Credit risk is **the probability of a financial loss resulting from a borrower's failure to repay a loan**. Essentially, credit risk refers to the risk that a lender may not receive the owed principal and interest, which results in an interruption of cash flows and increased costs for collection.

How to mitigate credit risk?

- Do not lend to risky customers
- Lend risky customers low amounts only
- Lend at higher interest rate to risky customers
- Repeated reminders to defaulters
- Legal Action (for high volumes)
- Additional interest on delayed payments

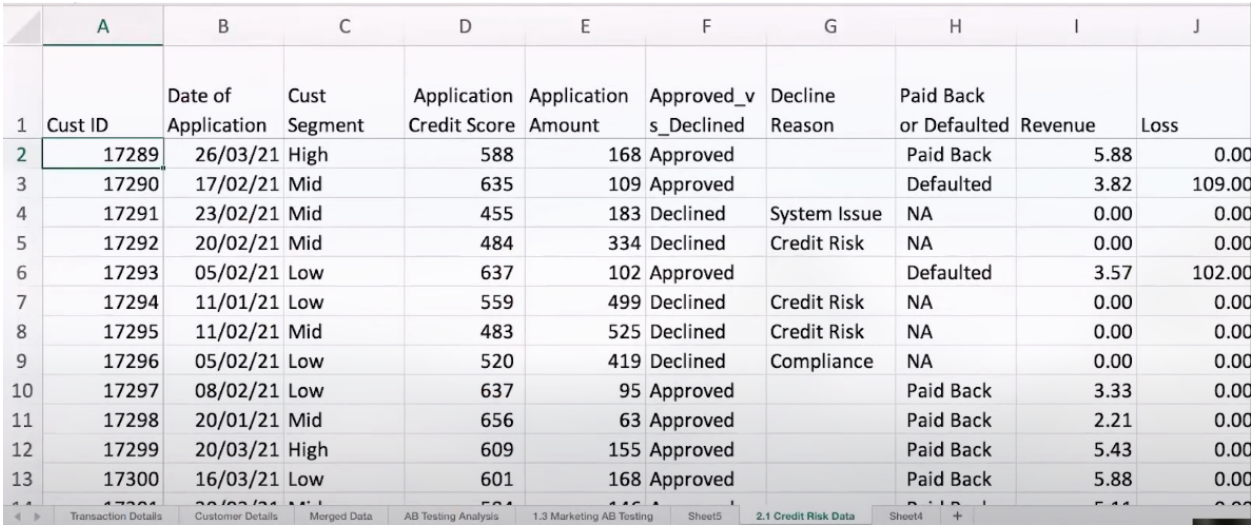
How companies figure out credit risk?

All financial institutions in India use a centralized credit score of a person to analyze their risk. They also report back to the platform in case of delayed or defered payments. This way a unqiue score of the user’s worthiness is maintained objectively. This is called CIBIL in India.

They can also use internal data to make the decision as CIBIL takes a fee to deliver the data and internal data would be much more rich in datapoints.

> 💡 CIBIL score does not depend on your income, but platforms can guess your income based on your transaction volume and act accordingly.

Credit Risk Dataset



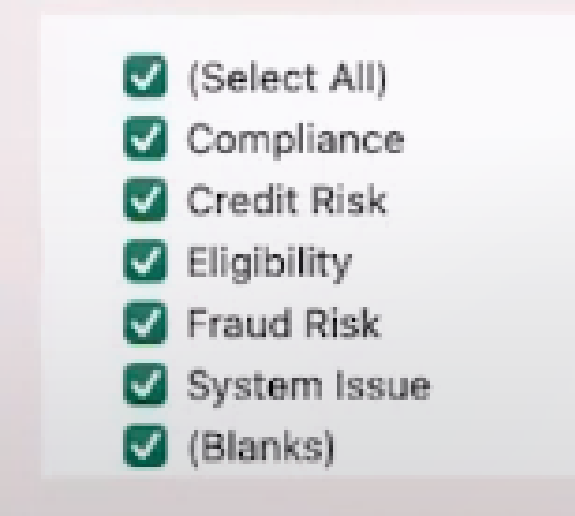
	A	B	C	D	E	F	G	H	I	J
1	Cust ID	Date of Application	Cust Segment	Application Credit Score	Application Amount	Approved_vs_Declined	Decline Reason	Paid Back or Defaulted	Revenue	Loss
2	17289	26/03/21	High	588	168	Approved		Paid Back	5.88	0.00
3	17290	17/02/21	Mid	635	109	Approved		Defaulted	3.82	109.00
4	17291	23/02/21	Mid	455	183	Declined	System Issue	NA	0.00	0.00
5	17292	20/02/21	Mid	484	334	Declined	Credit Risk	NA	0.00	0.00
6	17293	05/02/21	Low	637	102	Approved		Defaulted	3.57	102.00
7	17294	11/01/21	Low	559	499	Declined	Credit Risk	NA	0.00	0.00
8	17295	11/02/21	Mid	483	525	Declined	Credit Risk	NA	0.00	0.00
9	17296	05/02/21	Low	520	419	Declined	Compliance	NA	0.00	0.00
10	17297	08/02/21	Low	637	95	Approved		Paid Back	3.33	0.00
11	17298	20/01/21	Mid	656	63	Approved		Paid Back	2.21	0.00
12	17299	20/03/21	High	609	155	Approved		Paid Back	5.43	0.00
13	17300	16/03/21	Low	601	168	Approved		Paid Back	5.88	0.00

Transaction Details | Customer Details | Merged Data | AB Testing Analysis | 1.3 Marketing AB Testing | Sheet5 | 2.1 Credit Risk Data | Sheet4 | +

In this dataset we measure the

- Customer segment →Computed strata of the customer according to the platform
- Credit Score
- Amount of Loan
- Status → Approved or Declined
- Reason of Decline
- Payback Status → Paid Back or Defaulted for approved, NA for declined

Reasons of Declining Application:

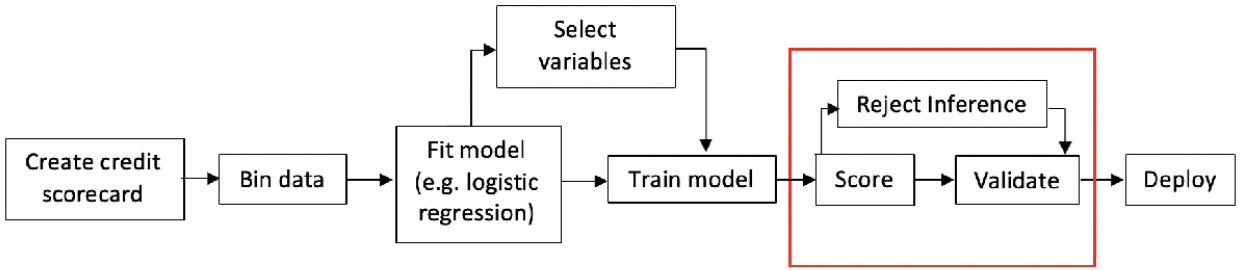


- Compliance → Does not meet one or more requirement (KYC not done, etc)
- Credit Risk → predicted to not being able to pay back the amount
- Eligibility → Not eligible for loan (age, etc)
- Fraud Risk → detected malicious intent and non-payback
- System Issue →Technical Difficulties

Reject Inferencing

Reject inference is a method for improving the quality of a credit scorecard by incorporating data from rejected loan applications. Bias can result if a credit scorecard model is built only on accepts and does not account for applications rejected because of past denials for credit or unknown nondefault status. By using the reject inference method, you can infer the performance of rejects and include them in your credit scorecard model to remedy this bias.

To develop a credit scorecard, you must identify each borrower as either "good" or "bad". For rejected applications, information to identify borrowers as "good" or "bad" is not available. You cannot tell for sure to which group a borrower would have belonged had they been granted a loan. The reject inference method allows you to infer whether a borrower would likely be "good" or "bad" enabling you to incorporate the rejected application data into the data set that you use to build a credit scorecard.



Decline decisions can be justified using external data like an improve or reduction in CIBIL score after the declination (assuming they got the same loan from elsewhere).

Calculations

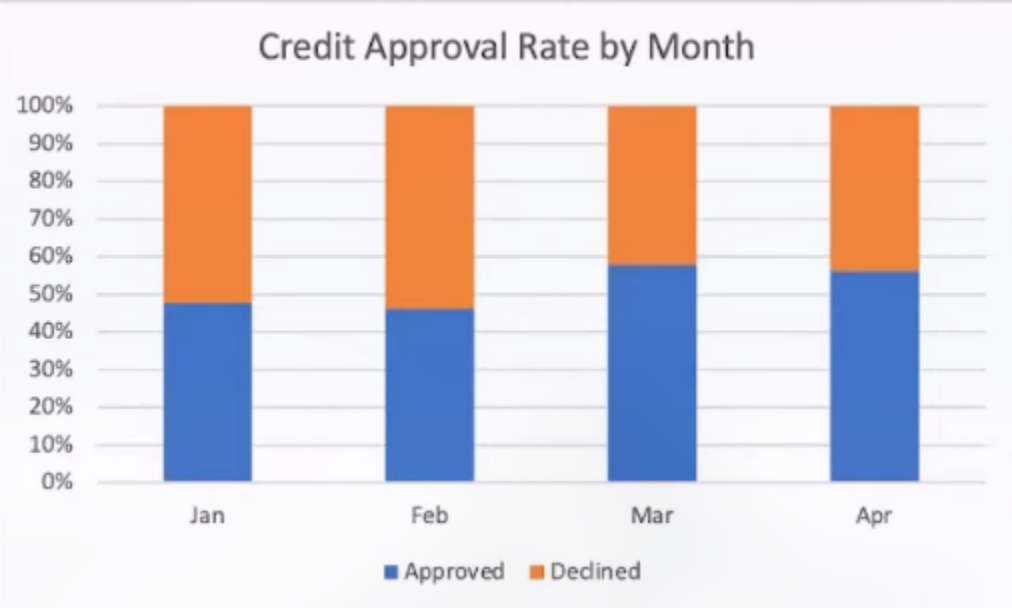
Lets calculate a few derived columns. Assuming a revenue of 3.5% commision, we calculate the revenue of each transaction if its accepted. We also calculate the loss as -100% amount if defaulted.

Revenue	Loss	Profit
5.88	0.00	5.88
3.82	109.00	-105.19
0.00	0.00	0.00
0.00	0.00	0.00
3.57	102.00	-98.43
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
3.33	0.00	3.33
2.21	0.00	2.21
5.43	0.00	5.43
5.88	0.00	5.88
5.11	0.00	5.11

Count of Approval and Decline Month Wise

Count of Cust ID	Column Labels		
Row Labels	Approved	Declined	Grand Total
Jan	296	325	621
Feb	525	611	1136
Mar	709	518	1227
Apr	41	32	73
Grand Total	1571	1486	3057

	Approved	Declined
Jan	48%	52%
Feb	46%	54%
Mar	58%	42%
Apr	56%	44%

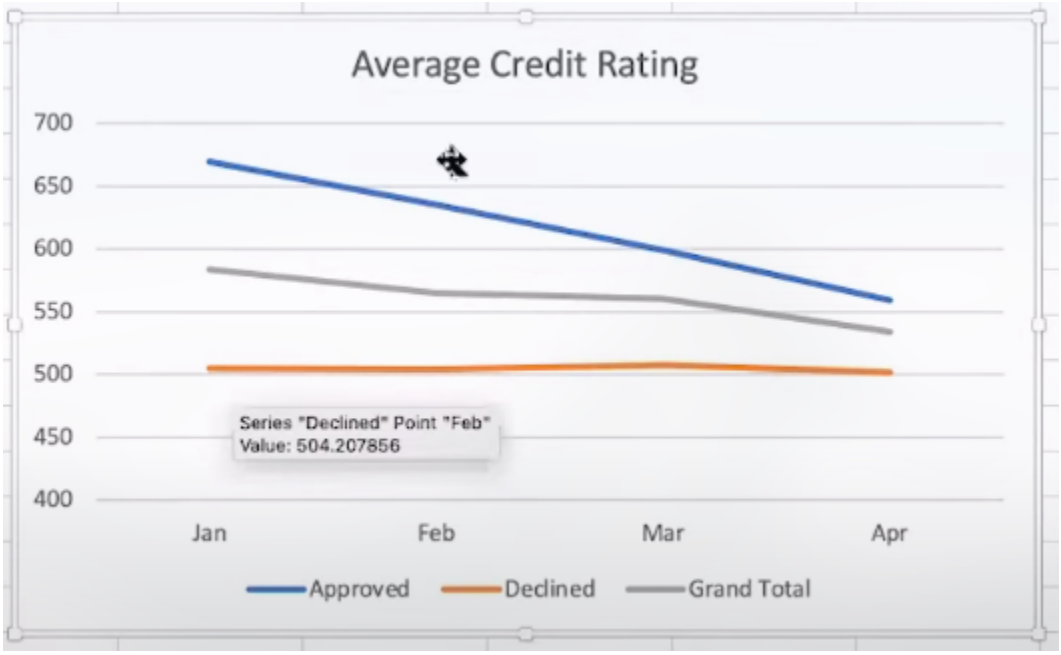


We can see approval increased in March.

Average Credit Score Month Wise

Average of Application Credit Score	Column Labels		
Row Labels	Approved	Declined	Grand Total
Jan	670	505	584
Feb	635	504	565
Mar	599	508	561
Apr	559	502	534
Grand Total	624	506	566

as we can see, the average credit score has also declined over the months. So although the credit score of declined customers is more or less the same, the credit score of approved customers has declined over the months.



Average,Min,Max Application value over time

Average of Application Amount	Column Labels		
Row Labels	Approved	Declined	Grand Total
Jan	73	358	222
Feb	112	359	245
Mar	150	363	240
Apr	184	395	276
Grand Total	124	361	239

Min. of Application Amount	Column Labels		
Row Labels	Approved	Declined	Grand Total
Jan	55	120	55
Feb	95	120	95
Mar	120	120	120
Apr	125	154	125
Grand Total	55	120	55

Max. of Application Amount	Column Labels		
Row Labels	Approved	Declined	Grand Total
⊞Jan	90	599	599
⊞Feb	130	600	600
⊞Mar	180	600	600
⊞Apr	242	574	574
Grand Total	242	600	600

As it is evident, large application values are always declined, but over the months we are increasing the approval amount.

	Column Label								
	Approved			Declined			Total Max. of A	Total Avera	Total Min. o
Row Labels	Max. of Application Amount	Average of Application Amount	Min. of Application Amount	Max. of Application Amount	Average of Application Amount	Min. of Application Amount			
⊞Jan	90	73	55	599	358	120	599	222	55
⊞Feb	130	112	95	600	359	120	600	245	95
⊞Mar	180	150	120	600	363	120	600	240	120
⊞Apr	242	184	125	574	395	154	574	276	125
Grand Total	242	124	55	600	361	120	600	239	55

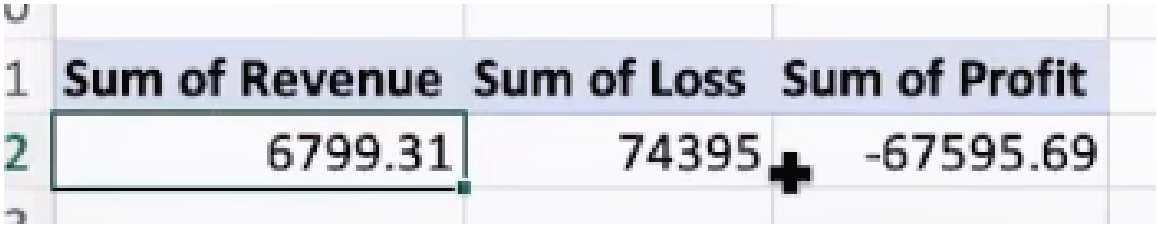
Equal rejection from all customer segment

Count of Cust ID	Column Labels				
Row Labels	Approved	Declined	Grand Total		
High	470	416	886	53%	47%
Low	554	538	1092	51%	49%
Mid	547	532	1079	51%	49%
Grand Total	1571	1486	3057		

Application amount over customer segment

Average of Application Amount	Column Labels		
Row Labels	Approved	Declined	Grand Total
High	134	364	242
Low	110	362	234
Mid	129	357	241
Grand Total	124	361	239

Profitability of the business



Sum of Revenue	Sum of Loss	Sum of Profit
6799.31	74395	-67595.69

As we can see the BNPL model makes substancial loss. It may be ok if it is a loss-leader model to attract customers and increase revenue, but it wont be making profit for the business. Although we are overestimating the loss (as the user may have paid off one or more EMI before defaulting) and underestimating the revenue (as the user may have still transacted if denied BNPL by using other modes).

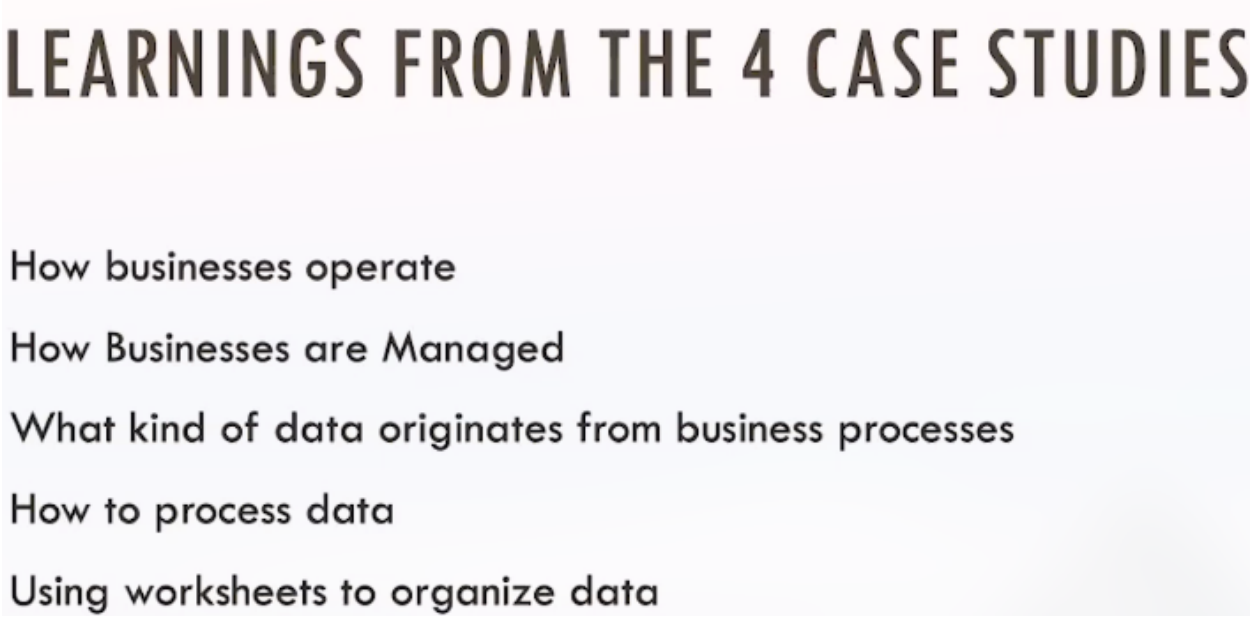
Comments from Business:

- Yes we relaxed the criteria of credit score over the months to approve more requests.
- The overall credit score of applicants reduces with time maybe because awareness of product spreads to people having lower scores and they start applying too. But it can also be an environmental thing of a global decline in credit score.
- Yes the approved amount has been increased from our end.
- The higher end customer should get more approvals, we will look into it.
- The aim of this product is to increase engagement and retention, not make profit, so a net loss is acceptable as long as it increases revenue of paybuddy through increase in engagement.
- We have a soft and hard limit for the loss and if it is too much we do take action on it.

How Business Operate

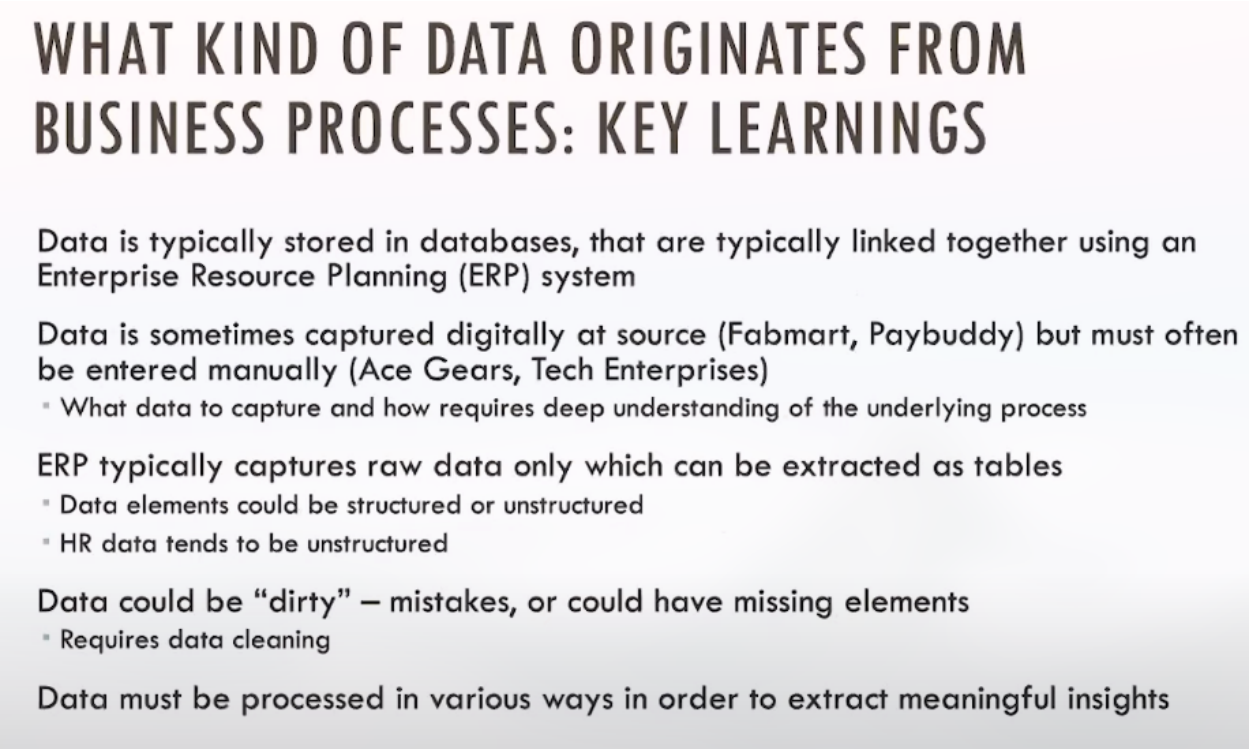
Tags	manage, operate, pivot tables, spreadsheets, vlookup
Course	BDM
# Week	12
Created time	@August 26, 2023 10:05 PM

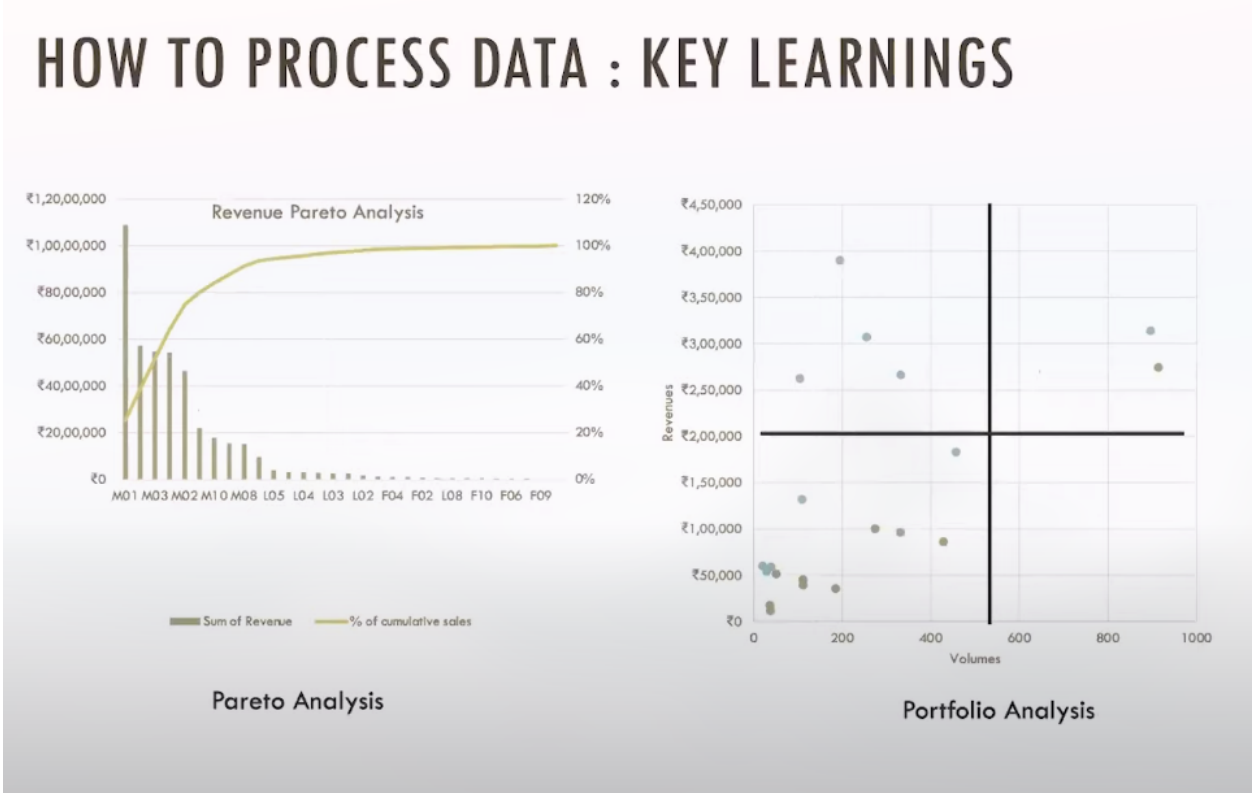
How Business Operate



How Businesses are Managed

Handling Business Data





Pareto Analysis: 80% of revenue/output comes from 20% of sources.

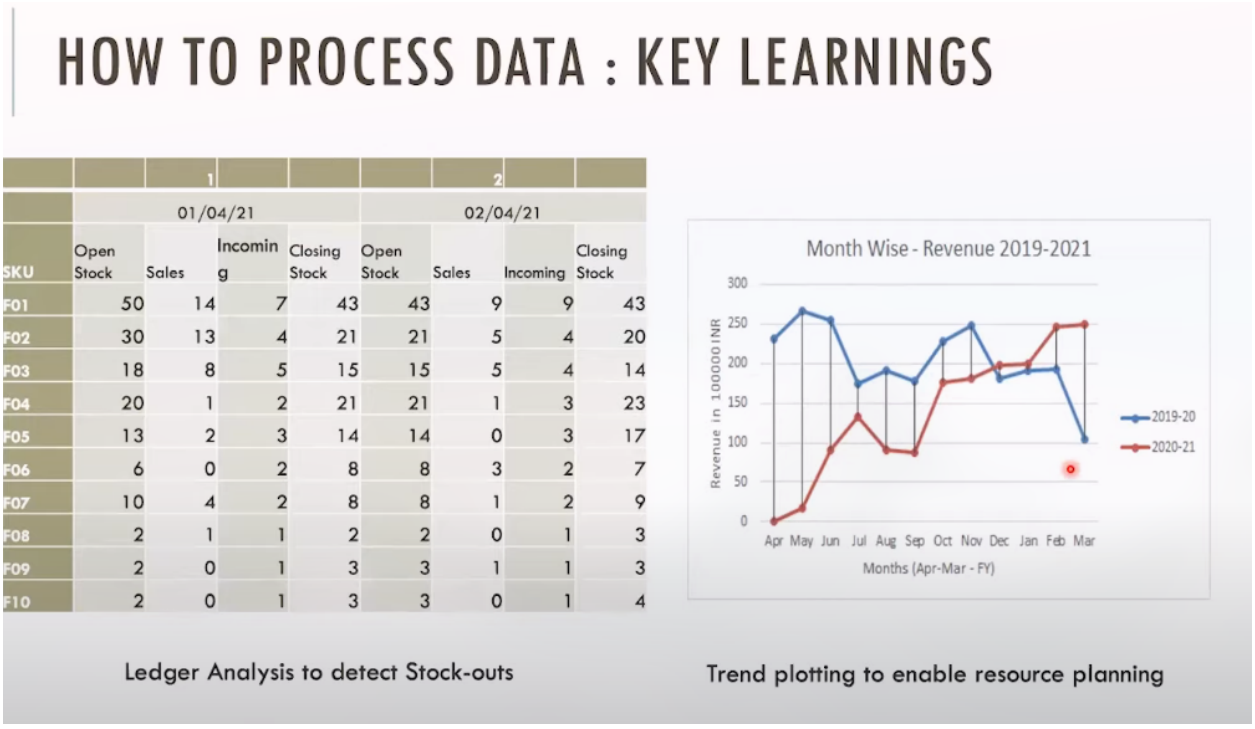
Pareto analysis is a technique used for business decision-making, but which also has applications in several different fields from welfare economics to quality control. It is based largely on the "80-20 rule." As a decision-making technique, Pareto analysis statistically separates a limited number of input factors—either desirable or undesirable—which have the greatest impact on an outcome.

Pareto analysis is premised on the idea that 80% of a project's benefit can be achieved by doing 20% of the work—or, conversely, 80% of problems can be traced to 20% of the causes. Pareto analysis is a powerful quality and decision-making tool. In the most general sense, it is a technique for getting the necessary facts needed for setting priorities.

Portfolio Analysis: Find the perfect combination that reduces risk and maximizes revenue.

Portfolio analysis is a quantitative method for selecting an optimal portfolio that can strike a balance between maximizing the return and minimizing the risk in various uncertain environments.

The aim of the portfolio analysis is **to make investment decisions within a group**, taking into account the influencing factors, market development (growth), consideration of the competition (market share), investment requirements and risk profile.

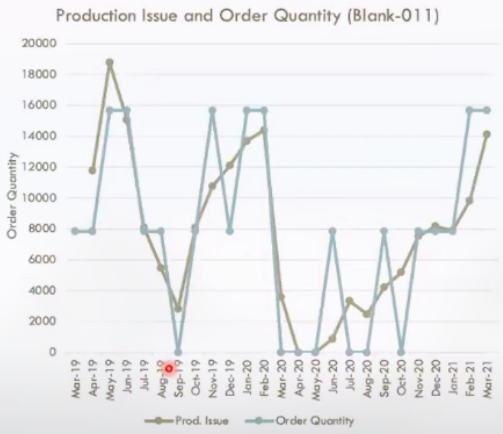


Ledger Analysis of Inventory:

$$\text{Closing Stock} = \text{Opening Stock} - \text{Sales} + \text{Incoming Stock}$$

HOW TO PROCESS DATA : KEY LEARNINGS

SALES DETAILS (GEAR ASSEMBLIES)	Average Sales Price (Oct 2020 - March 2021)	Direct Materials	Direct Labour	Production Overhead	Cost of Goods Sold	Gross Margin	Gross Margin %	Expected Margin
Gear Assembly 3 (BS4/6)	625.20	152	95	165	412.00	213.2	34.1%	Yes
Gear Assembly 4 (BS4/6)	515.89	130	65	145	340.00	175.9	34.1%	Yes
Gear Assembly 5 (BS4/6)	352.06	82	35	115	232.00	120.1	34.1%	Yes
Gear Assembly 6 (BS4/6)	205.00	60	25	45	130.00	75.0	36.6%	Yes



Unit level profitability to improve operational efficiency

Reorder point and safety stock to ensure smooth operations

Unit Level Profitability: Unit economic profitability is **a measure of profitability on a per-unit basis, or a customer basis**. In its simplest terms, this is revenues minus any costs associated with selling, which usually includes cost of goods sold and marketing, or customer acquisition cost.

HOW TO PROCESS DATA : KEY LEARNINGS

Channel	Percentage_count	Average_count_per_week	Normalised_Average_count_per_week	% of total application in channel	Normalised Avg score	Total score	Rank
Direct website	0.2037	2.4000	0.9231	0.6282	0.9285	2.6835	1
Employee referral	0.2010	2.4000	0.9231	0.5584	1.0000	2.6826	2
LinkedIn	0.2141	2.6000	1.0000	0.5366	0.9111	2.6618	4
Third Party	0.3812	1.8000	0.6923	0.6849	0.9138	2.6722	3

Converting unstructured to structured data

Generating rules to automate decision making

Ranking options using weighted scores

Some Other Learnings

Manipulating and Analyzing data using Excel