Summer Training

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‘Impact of covid-19 lockdown on food wastage behaviour of people in India’.

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PART-I

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ABBREVIATIONS

SARS	-	severe acute respiratory syndrome
COVID	-	coronavirus infectious disease
CDC	-	center for disease control
WHO	-	world health organization
FAO	-	food and agriculture organization
NRDC	-	national resources defense council
UNDP	-	united nations development program

INTRODUCTION

The infection SARS-CoV-2 that causes COVID-19 is by all accounts spreading principally from individual to individual, effectively and economically, prompting the respiratory sickness, and passing of more established grown-ups and individuals of all ages who have genuine basic ailments (CDC 2020). As a result of the nonappearance of explicit immunizations or medicines for COVID-19, numerous nations like India have picked a lockdown technique to stop the spread and to secure their population. This methodology means to switch pestilence development, decreasing case numbers to low levels by social separating the whole population, shutting schools and colleges and ending all unnecessary financial exercises (CDC 2020). During lockdown, individuals are encouraged to remain at home and to go out just to meet the most pressing needs like purchasing food and other essential commodities. Hence, COVID-19 caused a drop in family unit utilization and a move in their life and ways of managing money (Criteo Coronavirus Survey 2020). It is fascinating to think about these adjustments in individuals' practices in the more drawn out term. Then again, lockdown has prompted a lessening in vitality and material usage.

Indians squander as much food as the entire of United Kingdom devours – food wastage is a disturbing issue in India. Our roads and trash containers, landfills have enough confirmation to demonstrate it. Weddings, eateries, lodgings, social and family works, families heave so much food.

Food wastage is quick expecting genuine measurements. As per the Food and Agriculture Organization (FAO), an amazing 1.3 billion tons of food is being squandered every year. The FAO report further expresses that 33% of the absolute worldwide food creation is squandered, costing the world economy about $750 billion or Rs. 47 lakh crore.

Food wastage is an issue that has a worldwide scale. As per a report by the National Resources Defense Council (NRDC), 40 percent of the food goes uneaten in the US, though in Asia, India and China cause a misfortune 1.3 billion tons of food wastage consistently. Regarding by and large food squander rural produce, poultry and milk , India positions seventh, with the Russian Federation at the head of the rundown.

India's lower positioning is on the grounds that the vast majority of the nations positioning above it use a lot of their territory in raising poultry, while a significant lump of land in India is under farming and this clarifies the most elevated wastage of grains, heartbeats, foods grown from the ground that happens in India. An ongoing report directed by Indian Institute of Management, Kolkata, uncovered that lone 10 percent of nourishments get cold storeroom in India, this factor, joined by unseemly gracefully chain the executives, has brought about India turning into a noteworthy giver towards food wastage both at pre and post collect waste in grains, heartbeats, products of the soil.

As indicated by the United Nations Development Program (UNDP), up to 40% of the food in India is squandered. Around 21 million tons of wheat is squandered in India and half of all food over the world meets a similar destiny and never arrives at the poor. A few elements in family units can impact food waste, for example, in-store conduct (over-shopping) and family unit the executives rehearses (lack of foresight/food the board, stockpiling issues), just as psycho-social components (individual decision and way of life, food propensities, absence of cooking aptitudes).

PROBLEM STATEMENT

As indicated by the agriculture ministry, Rs. 50,000 crore worth of food delivered is wasted each year in the nation. India positions 103 among 119 nations in Global Hunger Index 2018. Wastage of food isn't demonstrative of just craving or contamination, yet additionally numerous monetary issues in the nation, for example, expansion.

• 25% of new water used to deliver food is eventually squandered, even as a great many individuals despite everything don't approach clean drinking water.

• Even though the world creates enough food to take care of double the world's current population, food wastage is unexpectedly behind the billions of individuals who are malnourished. The quantity of hungry individuals in India has expanded by 65 million more than the number of inhabitants in France.

• Acres of land are deforested to develop food. Around 45% of India's territory is corrupted fundamentally because of deforestation, impractical agrarian practices, and over the top groundwater extraction to satisfy the food need.

• 300 million barrels of oil are utilized to deliver food that is at last squandered.

The government has put forth numerous attempts to get control over food wastage however obviously, the depth of the issue is such that the effect of these efforts is scarcely sufficient.

RATIONALE

Food waste is a developing worldwide issue, representing a test to food security, sanitation, the economy and ecological manageability. The 2019–2020 coronavirus ailment (COVID-19) is a general medical problem. Lockdown is among choices recommended to lessen spread of the infection. This examination meant to deciding the effect of COVID-19 lockdown on Indian shopper mindfulness, perspectives and practices identified with food wastage.

An online survey was conducted during the time of COVID-19 lockdown. The survey consists information on sociodemographic data, awareness and attitudes toward food waste, food purchase behavior and household food expenditure estimation; extent of household food waste; willingness and future intentions to reduce food waste.

Thus, the aim of this research was to find out the impact of covid-19 lockdown on food wastage behavior changes and attitudes regarding food wastage.

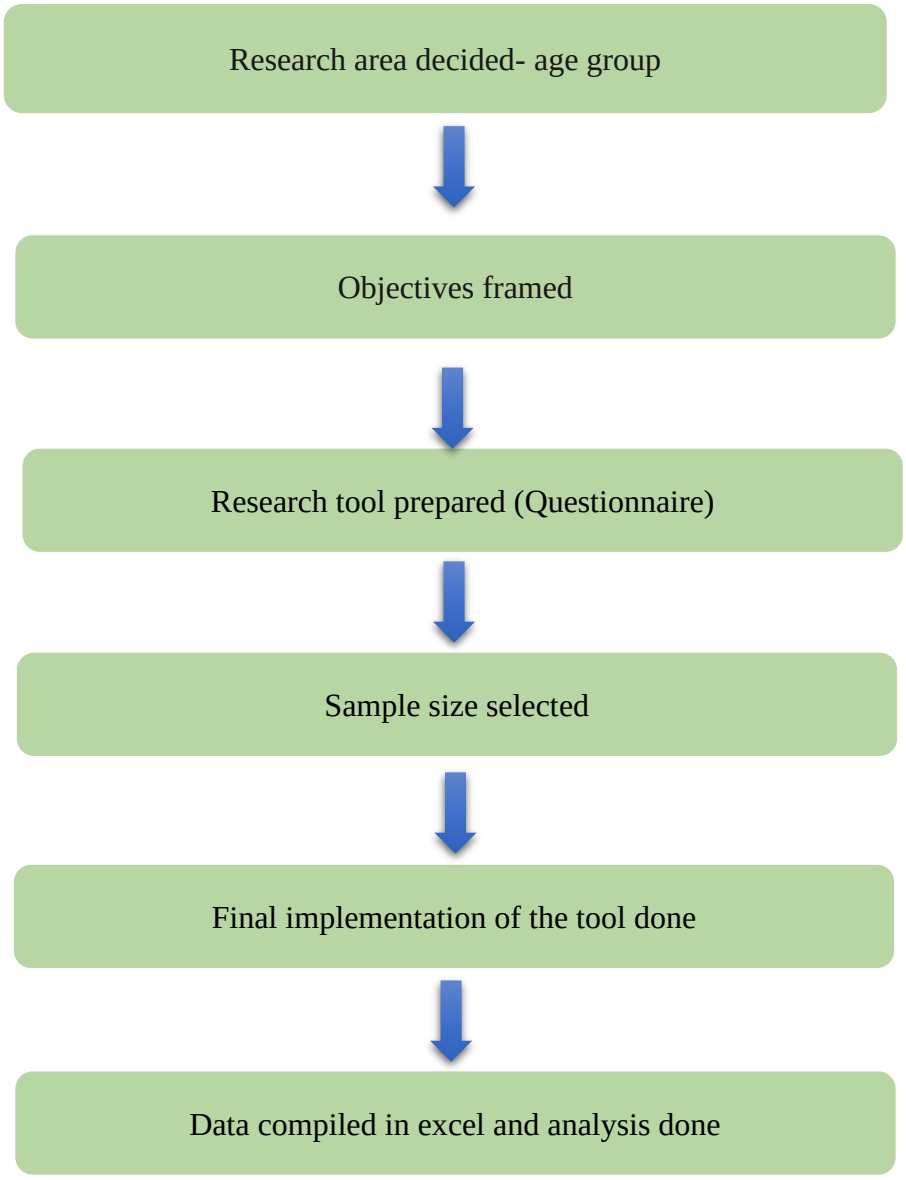
RESEARCH QUESTIONS

What is the impact of covid-19 lockdown on food wastage behavior of people of India and changes in behavior and attitudes regarding food wastage ?

OBJECTIVES

- To find the awareness of food wastage among people in India.
- To find behavior of people towards food wastage, food purchase and expenditure.
- To find the impact of lockdown on food wastage behavior of people of India.

METHODOLOGY



DATA COLLECTION

Study Design- The study was based on an online survey in India using a structured questionnaire. Research was conducted through cross-sectional observational study, participants were from all over India. The duration of complete research was two months from April 1 to may 31, 2020. A semi-structured questionnaire was administered using online google forms (https://forms.gle/jx5iaaArt5oKdtx68).

Sampling- Sample size is of 385 respondents. These people will belong to age group of 15-59 years because they economically active population. This age group is further decided because people of this age generally active for purchasing food and uses smart phones so they can respond to online google form. According to census 2011, population of India is 1,210,854,977 out of which 771556791 is economically active population living in urban area. Sample size is calculated by taking 95% confidence interval at 5% margin error. However, we got total of 216 responses (56.1%) who got agreed to participate and completed the survey.

Data collection- The questionnaire consisted of 22 multiple choice questions structured in 5 sections, namely socio-demographic characteristics of the respondents (6 questions), awareness and attitude towards food wastage in lockdown (4 questions), food purchase and preparation behavior (8 questions), quantity and extent of food wasted (2 questions) and at last, willingness and information needs to reduce household food waste (2 questions). The link for the survey was distributed among the participants via email, linkedIn and social media. After reading introduction, purpose of the study and assurance of keeping all the information confidential, participants proceeded further to answer the questions which appeared further in the form.
Data collection tool is attached in annexure.

DATA COMPILATION AND ANALYSIS

Compilation

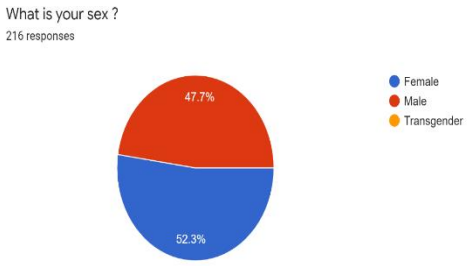
Data compilation is doing using Microsoft excel. 385 respondents from India (urban area) were taken as sample. All the answers to the questions were entered in a password locked laptop for further analysis and interpretation. All the data was verified and double checked before initiating analysis.

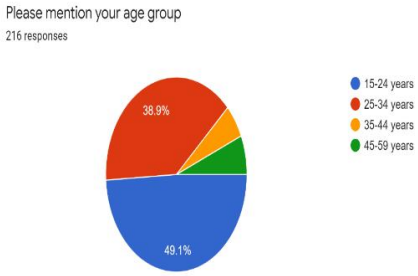
Analysis

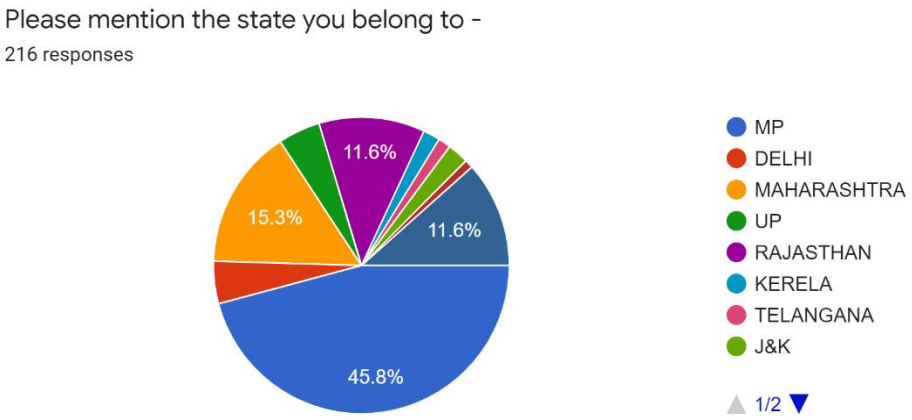
The objective of the study were to find the behavior of people towards food wastage. Analysis done using Microsoft excel.

INTERPRETATION

1) Socio-Demographic characteristics of the respondents







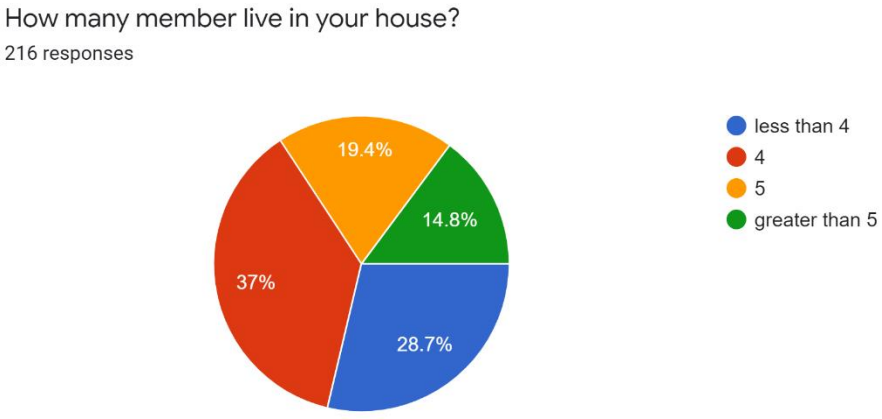


TABLE 1: Socio-demographic characteristics of respondents (n = 216)

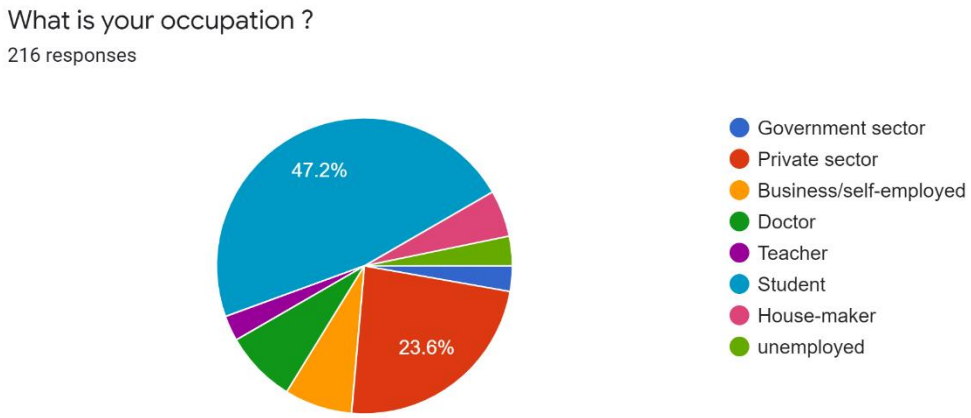
VARIABLES	CATEGORY	n(%)
Gender	Female	113 (52.3%)
	male	103 (47.7%)
	transgender	0
Age	15-24 years	106 (49.1%)
	25-34 years	84 (38.9%)
	35-44 years	12 (5.6%)
	45-59 years	14 (6.5%)
No. of member in house	Less than 4	62 (28.7%)
	4	80 (37%)
	5	42 (19.4%)
	More than 5	32 (14.8%)
Occupation	Government sector	6 (2.8%)
	Private sector	51 (23.6%)
	Business/ self employed	16 (7.4%)
	Doctor	17 (7.9%)
	Teacher	6 (2.8%)
	Student	102 (47.2%)
	House-maker	11 (5.1%)
	Unemployed	7 (3.2%)
Education level	Post-graduate	81 (37.5%)
	Graduate	124 (57.4%)
	Primary & high school	11 (5.1%)

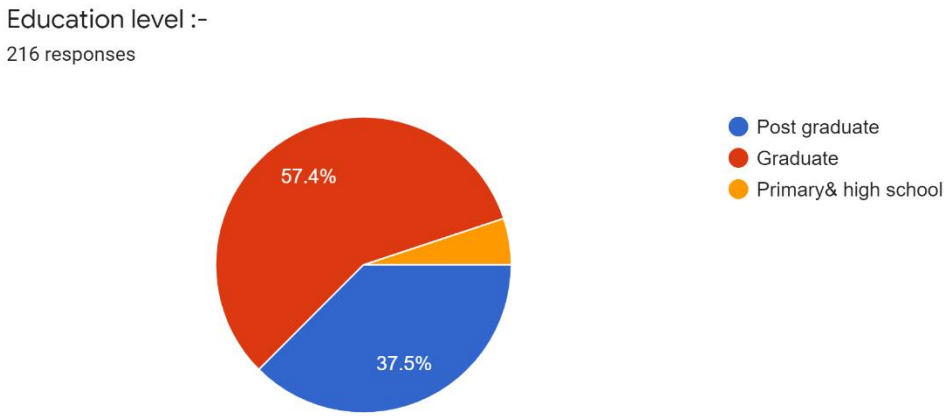
- Demographics research shows that 52.3% of the respondents are women, and 47.7% are male respondents. This shows that women are more active in maintaining food wastage and household shopping.

- Majority of the respondents lie in age group of 15-24years whereas the least participation was from age group of 35-44 years which is only 5.6% of total respondents.

- The graph shows that maximum participation state was Madhya Pradesh. 45.8% people belongs from this state.

- 14.8% live in households with more than 5 members whereas 37% live in household with 4 members.

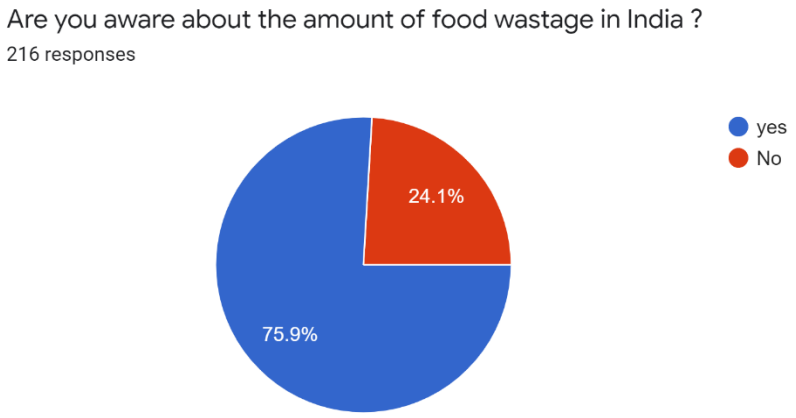


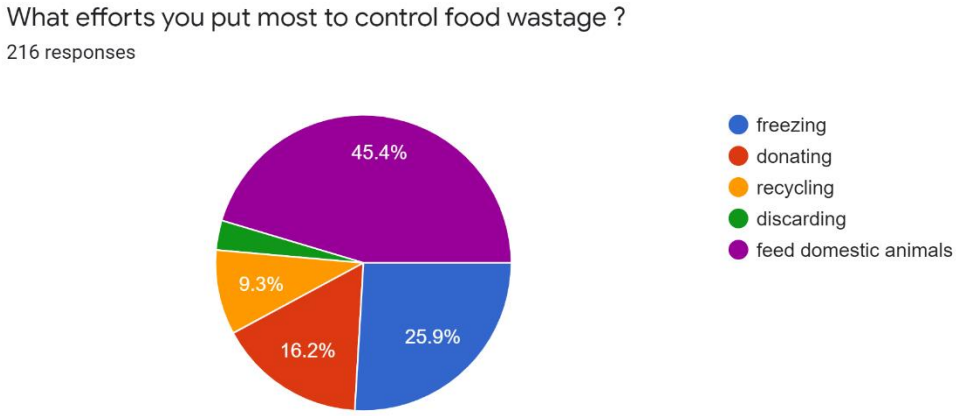


- Regarding the occupation of respondents; the graph shows that 47.2% of respondents are currently studying and 23.6% of respondents work in private sector. Surprisingly, housemaker constitutes of only 5.1% of total sample population.

- Graph also shows that 57.4% of respondents are graduate whereas 37.5% are highly educated with post graduate degree.

2) Awareness among people and their attitude towards food wastage during covid-19 lockdown





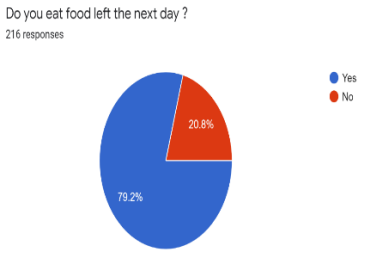


TABLE 2: Awareness and attitude towards food wastage during lockdown (n=216)

CRITERIA	INDICATOR	n (%)
Reported awareness about amount of food wastage	Yes	164 (75.9%)
Efforts put most to control food wastage	freezing	56 (25.9%)
	donating	35 (16.2%)
	recycling	20 (9.3%)
	discarding	7 (3.2%)
	Feed domestic animals	98 (45.4%)
Eating food left next day	Yes	171 (79.2%)
Lockdown impacted level of food waste	Yes	73 (33.8%)
	No	88 (40.7%)
	May be	55 (25.5%)

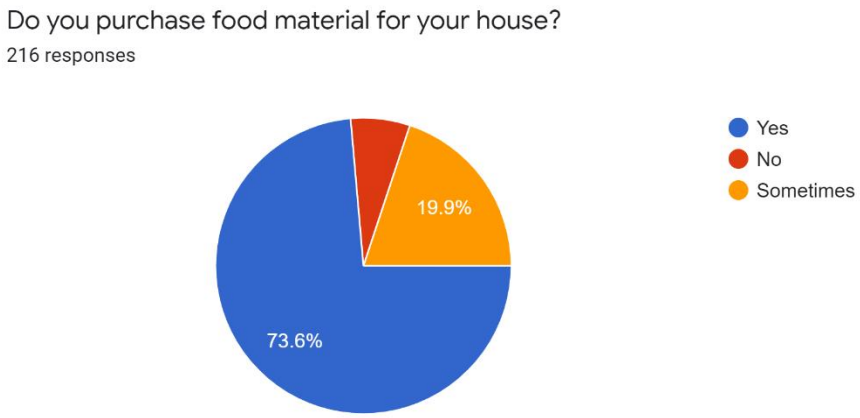
Since food waste is mostly inferable from buyers, it was basic to assess shopper awareness, particularly during a bizarre circumstance like the COVID-19 pandemic. Our results shows that a large majority (75.9%) of respondents are aware about the amount of food wastage in India. In addition, huge relations have appeared between detailed awareness, age and education. Our outcomes reports huge relationship between food waste information and socioeconomics such age and business status.

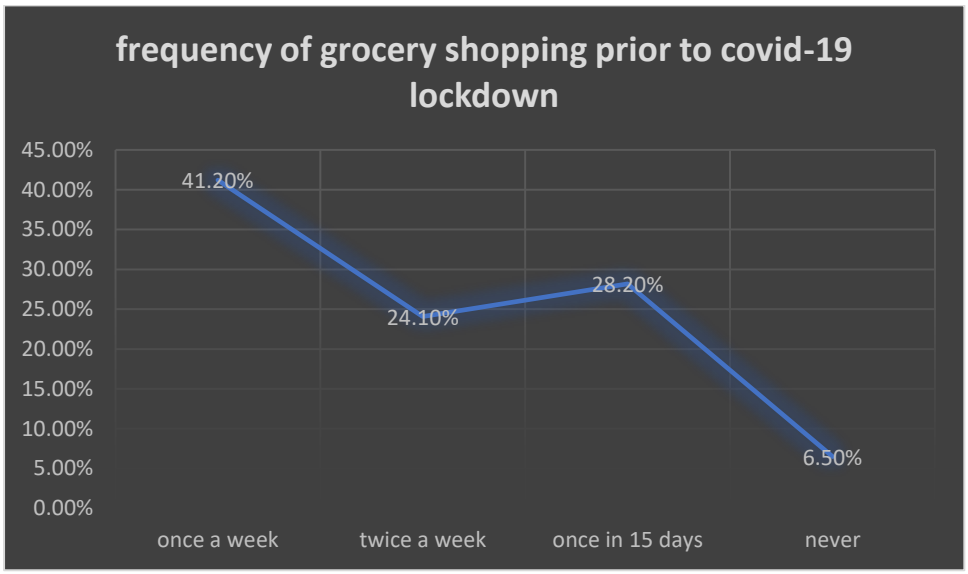
To the question that whether lockdown has impacted their level of food waste- 41% of respondents said yes. Age and training expanded fundamentally revealed efforts to control food wastage during COVID-19 lockdown. Since there was limitation on going out at any restaurant for eating, this triggered home cooking and thus purchased food items were utilized. In addition, this circumstance expanded mindfulness, most likely, due food accessibility as opposed to natural contemplations.

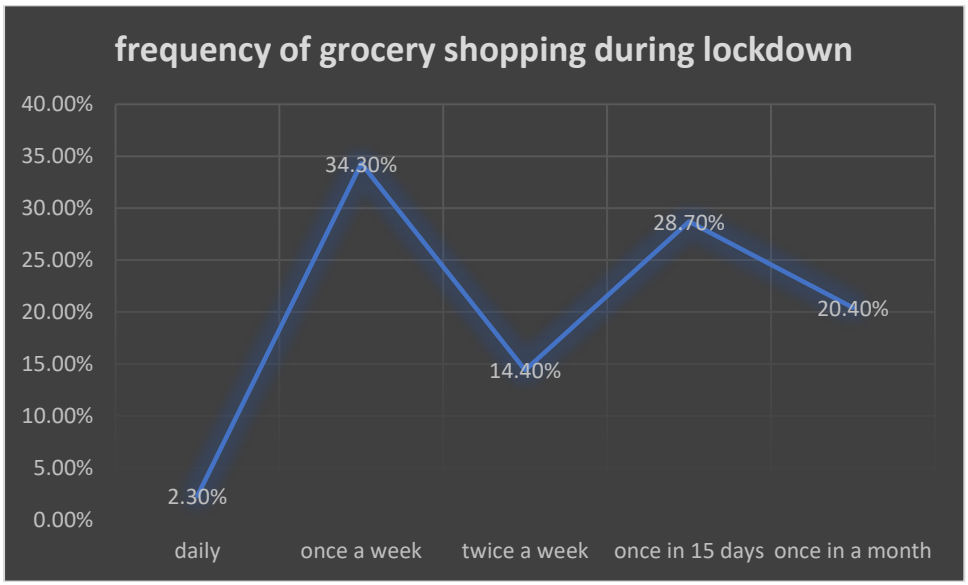
Respondents were also made to ask qualitative questions about their level of awareness. To the question that what efforts they put most to control food wastage. It was found that 45.4% of people feed domestic animals to control food wastage whereas only 3.2% of people discard the leftover food.

To the question whether they eat the food left next day 79.2% said yes. This shows increased level of awareness and changes in perspectives, toward food waste during times of emergency. This elevated degree of awareness about the food waste establishes a significant condition for a future behavior change.

3) Food purchase behaviors and attitude of people towards COVID-19 lockdown

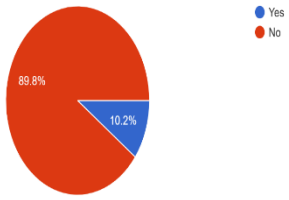






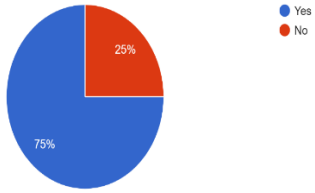
Do you order food online during lockdown ?

216 responses



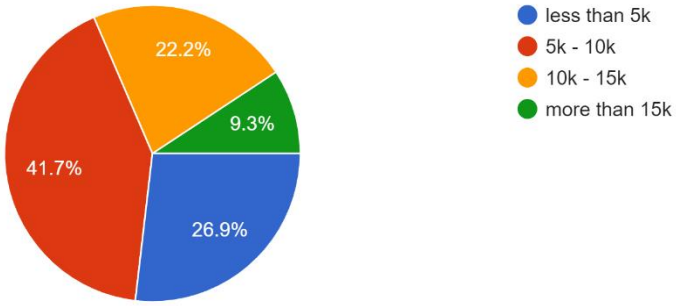
Do you buy discounted food products (buy 1 get 1 free) ?

216 responses



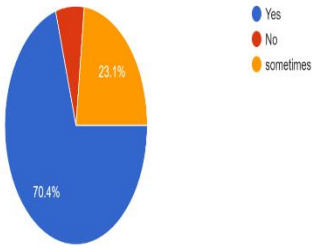
Household monthly food expenditure -

216 responses



Do you do a shopping list ?

216 responses



Has covid-19 lockdown changed your shopping habits ?

216 responses

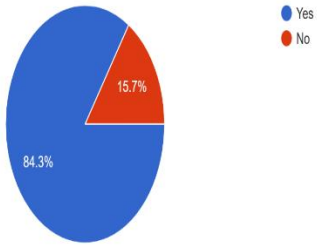


TABLE3: Food purchase behaviour during covid-19 lockdown

FOOD PURCHASE BEHAVIOUR	n (%)
Purchases food material for the house	159 (73.6%)
Order food online during lockdown	22 (10.2%)
Buy discounted food products	162 (75%)
Do a shopping list	152 (70.4%)
Covid-19 lockdown changed their shopping habits	182 (84.3%)

- 73.6% of people purchase food material for their house and 19.9% do it sometimes.
- Prior to lockdown 41.2% of people used to purchase food material once in a week. However, this percentage got decreased to 34.3% during the time of covid-19 lockdown.
- There were only 2.3% of people who go for grocery shopping daily during the covid-19 lockdown.

  These results show that people avoided going out unnecessarily during this pandemic. During COVID-19 pandemic, there was a gigantic worry about security. In this manner, stores have imparted, as a method of consoling clients, on various wellbeing estimates executed, for example, social distancing, extra neatness and cleanliness.

  In developed nations, a greater amount of half of clients proclaimed to decide to shop online mostly because of COVID-19 (Criterio Coronavirus Survey 2020). Almost 90% of people do not give preference to order food online during covid-19 lockdown. Hence, our outcomes demonstrated an effect of COVID-19 pandemic on online food requesting. This can be clarified by the worry of wellbeing just as by the lockdown itself.

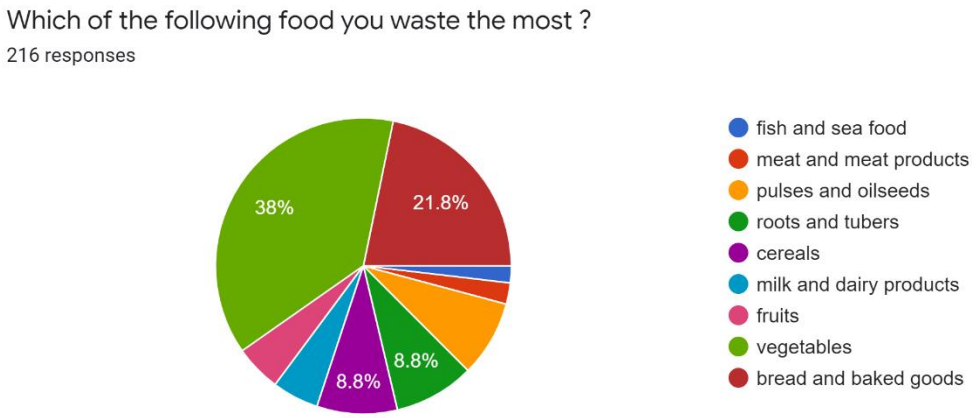
  Regarding their household food expenditure, 41.7% of the respondents affirmed to spend monthly between Rs 5000 and 10000, 26.9% spend less than 5000 per month on food, 22.2% spend somewhere near Rs 10000-15000 and only 9.3% of the respondents monthly food expenditure is more than Rs 15000. It would be normal in this setting the manner in which cash was spent during COVID-19 lockdown may be extraordinary. As indicated by Durante (2016), people would be increasingly vital about how they go through their cash under pressure. As it were, focused on customers increased expenses on essential needs and spend less on optional things.

- According to our study, 70.4% of respondents proclaimed to utilize a shopping list. Doing food shopping list before going to market is considered as an effective food waste avoidance device at the family unit level, by forestalling the acquisition of surplus nourishments (van Geffen et al. 2020).

- When asked about do they buy discounted food products, 75% of people always buy these products. Ongoing discoveries have brought up that individuals who are cost situated as well as have an appreciation for extraordinary offers will in general waste less (Jörissen et al. 2015; van Geffen et al. 2020).

- When asked about "Has COVID-19 lockdown changed your shopping habits?," 84.3% of people have said yes.

4) Quantity and type of household food waste during COVID-19 lockdown



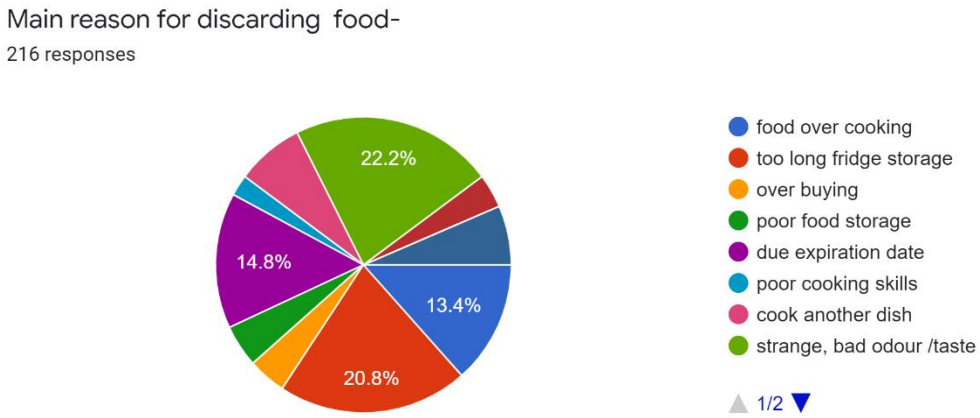


TABLE 4: Type of household food wasted during lockdown

FOOD WASTED THE MOST	n (%)
Vegetables	82 (38%)
Bread and baked goods	47 (21.8%)
Cereals	19 (8.8%)
Roots and tubers	19 (8.8%)
Pulses and oil seeds	18 (8.3%)
Milk and dairy products	11 (5.1%)
Fruits	11 (5.1%)
Meat and meat products	5 (2.3%)
Fish and sea food	4 (1.9%)

MAIN REASON FOR DISCARDING FOOD	n (%)
Strange bad odour/taste	48 (22.2%)
Too long fridge storage	45 (20.8%)
Due expiration date	32 (14.8%)
Food over cooking	29 (13.4%)
Cook another dish	16 (7.4%)
Moulds growing on the food	14 (6.5%)
Poor food storage	10 (4.6%)
Overbuying	9 (4.2%)
Too large food packages	8 (3.7%)
Poor cooking skills	5 (2.3%)

Subjective evaluations were mentioned with respect to the measure of food normally disposed of and the effect of the COVID-19 pandemic. The revealed aim of abstaining from disposing of purchased things was fundamentally expanded with age and training. These discoveries propose a superior food arranging by customers during COVID-19 lockdown: food has been most likely bought with thought to how it is going to be utilized. Actually, arranging has been appeared to forestall overbuying and overcooking. The difference in conduct was most likely connected with lost salary and to a dread of food deficiencies, disabling food accessibility.

Respondents were additionally solicited to evaluate the complete rate from food discarded by classifications, communicated as the level of bought food things. In spite of the fact that these outcomes are just gauge and afterward ought to be deciphered cautiously, they stay helpful to more readily comprehend the manner in which customers see their degrees of waste, during the COVID-19 lockdown.

According to our survey, the food which is wasted the most are vegetables (38%), followed by bread and baked goods (21.8%) and to a lesser extent cereals, roots and tubers (8.8%). The food which is wasted the least are fish and seafood, meat and meats products, it consist of less than 3% of purchased foods.

During COVID-19 lockdown, it creates the impression that a large portion of the respondents have set up a technique of sparing, putting away and eating extras. These practices are known to control the degree of household food squander. From sociodemographic study it very well may be seen that ladies, people over 40 years of age and college taught individuals will in general prevent wastage of extras by freezing, give or reusing them, though as men and less instructed individuals tend to discarding them more or to utilize them for creature taking care of.

To pick up knowledge into food waste, respondents were approached to show the principle purpose behind disposing of food .

 Responses uncover the most referred to reasons were strange bad odour and taste (22.2%) and a too long storage in the fridge (20.8%). Food safety is the fundamental reasons of food waste in Indian family units.

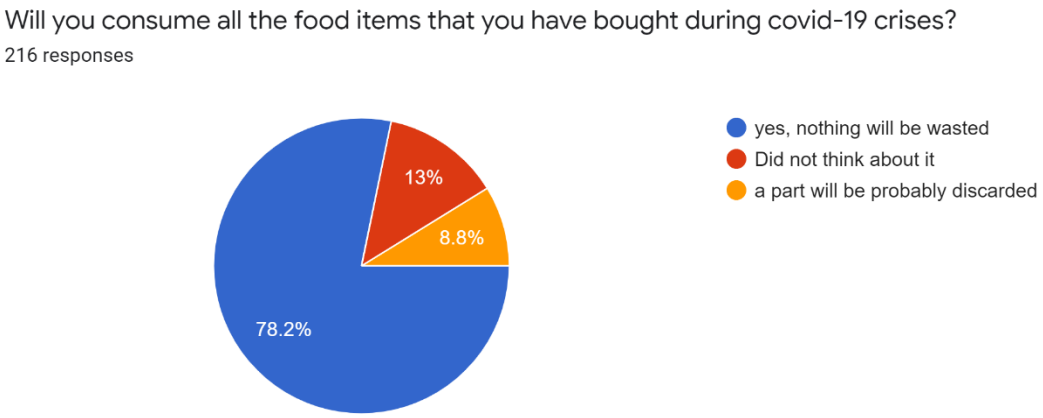
 4.2 percent of respondents have asserted over buying as a fundamental explanation of food wastage. This was identified with the purposeful over-provisioning, specifically in short-lived

food things, identified with COVID-19 lockdown.

 14.8% accepted that due expiration date and 13.4% food overcooking are fundamental purpose behind disposing of food, showing that purchasing and cooking excessively, not completing dinners and wrong food stockpiling methods were perceived as huge drivers of food squander by buyers. Purchasers stress over food contamination when settling on food dispose of choices. Over cooking was most likely identified with the trouble to evaluate the amount to cook per individual or how to cook the correct parts.

Taken together, our investigation has demonstrated the positive impact of COVID-19 lockdown on shoppers' practices toward food squander anticipation. Comparable discoveries were seen by Abeliotis et al. (2014) and Fanelli and Di Florio (2016), in the midst of emergency. Our discoveries have called attention to the need to actualize Government motivation systems including data battles, to assist buyers with improving home cooks' effectiveness as far as appropriate amounts, and food stockpiling just as to all the more likely survey food safety, and to reuse extras.

5) Willingness and future intentions to reduce household food waste



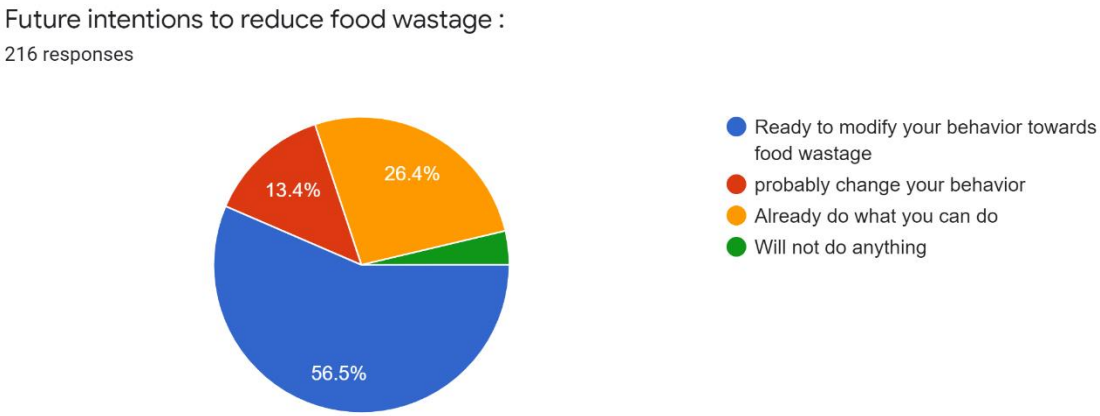


TABLE 5: Practices and future intentions towards food waste prevention

REPORTED BEHAVIOUR TOWARDS FOOD CONSUMPTION BOUGHT DURING COVID-19 CRISES	n (%)
- Nothing will be wasted	169 (78.2%)
- Did not think about it	28 (13%)
- A part will be probably discarded	19 (8.8%)
REPORTED FUTURE INTENTIONS TO AVOID FOOD WASTAGE	n (%)
- Ready to modify their behavior towards food wastage	122 (56.5%)
- Probably change their behavior	57 (26.4%)
- Already do what they can do	29 (13.4%)
- Will not do anything	8 (3.7%)

- To the question “Will you consume all the food items that you have bought, during COVID-19 crisis,” 78.2% have said yes that nothing will be wasted, whereas 13% did not think about this issue and 8.8% declared a part will be probably discarded. This result confirmed the increased awareness in food waste issue, during COVID-19 crisis. This motivation seen could be because of food availability and economical problem, rather than an environmental concern. COVID-19 lockdown has led to a loss of income-earning opportunities, mainly for independent workers which could cause a contraction of consumption. So, in stressful situation, consumers would rather prefer to save than to spend.

- Above pie chart shows respondent’s future intentions to cut down food wastage. More than half of respondents (56.5%) claimed to be ready to modify their behavior toward food waste. Around 13.4% of respondents said that they will probably change their behavior. These behavioral intentions can constitute a basis for implementing food wastage prevention and reduction measures. In contrast, 26.4% of people believes that they already do what they can do. In addition, 3.7% said that they will not do anything: they might probably externalize the responsibility of food wastage, suggesting a lack of problem awareness and a denial of the food waste issue.

DISCUSSION OF THE FINDINGS

Our research expected to decide the effect of COVID-19 lockdown on Indian purchaser awareness, perspectives and practices identified with food wastage. An online survey was led during the initial fourteen days of COVID-19 lockdown. The review gathered data on segment information, awareness and mentalities toward food squander, food buy behaviour and family food consumption estimation; degree of family food waste; readiness and data needs to decrease food squander.

This survey consists of 385 respondents. Unfortunately, we got just 216 reactions. About 75.9% of respondents professed to know about food waste, and the COVID-19 lockdown would affect for 33.8% of population, their level of wastage, and for 84.3% their shopping for food propensities has changed. Curiously, the COVID-19 lockdown improved food shopping exhibitions and pushed toward a positive social change with respect to food wastage: 78.2% respondents proclaimed nothing of what they purchased would be disposed of, and the greater part of the respondents have set up a system of saving, storing and eating extras.

The most referred to reasons given for discarding of food were strange bad odour/taste (22.2%) and too long fridge storage (20.8%). Consumer’s change in food waste prevention may be presumably determined more by the socioeconomical setting of the COVID-19 lockdown (for example food accessibility, limited developments, loss of pay). Finally, our investigation called attention to the customers' needs of information for making further move.

CONCLUSION AND RECOMMENDATIONS

Our study has set up that COVID-19 outbreak lockdown has made respondents endeavour toward lessening food waste. Respondents have created positive perspectives toward food waste prevention; during the first two weeks of COVID-19 lockdown, they have adjusted their habits that have been seen as near the great practices. Our findings recommended that food waste prevention was most likely determined more by the socioeconomical setting of the COVID-19 emergency (i.e., food accessibility, confined developments, loss of pay), than by a pro environmental concern.

So as to keep up the positive COVID-19-driven practices toward food waste avoidance, instruction and communication campaigns should be increased to bring issues to light of general food squander results and to bring issues to light of advantages of counteraction. In addition, our review has called attention to the need to give purchasers abilities and tools to manage their food-related activities. At the legislative level, guidelines ought to be executed at the family level and government ought to force punishments.

Some of the limitations of our research are connected to the data gathering technique. Online studies are modest, easy to set up and don't require a physical contact between the questioners and the respondents that was a worry during COVID-19 episode. They give an enormous perspective on waste related issues. However, online studies raise the constraint of examining technique: they can't reach to individuals that are not happy with innovation or don't have access to internet or smartphones, this may include some of the low income, poorly educated persons or elderly. In addition, online surveys do not allow a depth analysis of the results. This can be accomplished through subjective investigations. A huge limitation of our study is that our sample size was of 385 respondents but due to lockdown online survey was conducted and we could only receive 216 responses.

Taking everything into account, our investigation adds to a better understanding of how an emergency circumstance influences customer conduct and brings issues to light with respect to food squander. COVID-19 outbreak can give the open door after the emergency and finding effective medicines/immunizations, to make improvements in reduction level of food waste. Further sustainable solutions to overcome food waste problem could be developed.

Taken together, our investigation has indicated the positive impact of COVID-19 lockdown on purchaser's practices toward food waste avoidance. Our discoveries have brought up the need to actualize Government motivating force instruments including information campaigns, to assist shoppers with improving home cooks productivity regarding appropriate amounts, and food stockpiling just as to more readily survey sanitation, checking the expiry dates of the products prior to purchase and to reuse extras. Respondents should be better educated about the negative effects of food waste on nature and on the economy. Responses on fundamental conditions expected to limit their food waste later on were altogether connected with age, education and number of members in the family unit. Information is the most generally actualized method for advancing food wastage avoidance and decrease. Data can expand food waste awareness, which thus can promote pro environmental behaviour change. Information tools must be designed to specifically address the specific knowledge gaps that drive wasteful practices. A few nations have founded arrangements to support family unit waste decrease and reusing, by for example, embedding levy based waste administration frameworks (Chalak et al. 2016).

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ANNEXURE

Questionnaire

1. Age
2. Sex
3. State
4. How many members live in your house?
5. What is your occupation?
6. Education level-
7. Do you purchase food material for your house
    i. Yes
    ii. No
    iii. Sometimes
8. How often do you purchase food material?
    i. Once a week
    ii. Twice a week
    iii. Once in 15 days
    iv. Never
9. Are you aware about the amount of food wastage in India?
    i. Yes
    ii. No
10. What efforts you put most to control food wastage-
    i. Freezing
    ii. Donating
    iii. Recycling
    iv. Discarding
    v. Feed domestic animals
11. Do you eat food left the next day?
12. Did covid-19 lockdown impacted your level of food wastage?
    i. Yes
    ii. No
    iii. May be
13. How often do you go for grocery shopping during covid-19 lockdown?
    i. Daily
    ii. Once a week
    iii. Twice a week
    iv. Once in 15 days
    v. Once in a month
14. Do you order food online during lockdown?
15. Household monthly food expenditure-

Less than 5000	
5000-10000	
10000-15000	
More than 15000	

16. Do you buy discounted food products (buy 1 get 1 free)?
17. Do you do a shopping list?
18. Has covid-19 lockdown changed your shopping habits?
    i. Yes
    ii. No
19. Will you consume all the food items you have bought during covid-19 crises?
    i. Yes, nothing will be wasted
    ii. Did not think about it
    iii. A part of it will probably discarded
20. Which of the following food you waste the most-

Fish and sea food	
Meat and meat products	
Pulses and oil seeds	
Roots and tubers	
cereals	
Milk and dairy products	
fruits	
Vegetables	
Bread and baked goods	

21. Main reason for discarding food-

Food over cooking	
Too long fridge storage	
Over buying	
Poor food storage	
Due expiration date	
Poor cooking skills	
Cook another dish	
Strange bad odour taste	
Too large food packages	
Moulds growing on the food	

22. Future intentions to reduce food wastage-
    i. Ready to modify your behaviour
    ii. Probably change your behaviour
    iii. Already do what you can do
    iv. Will not do anything

REPORT
(PART-II)

Online course done on data analytics for lean six sigma by University of Amsterdam from Coursera

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2019-2021

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2020

NAME OF THE COURSE :-

Data Analytics for Lean Six Sigma

COURSE DESCRIPTION :-

The course is available on Coursera and is offered by University of Amsterdam. IBIS UvA has over 20 years of experience with (Lean) Six Sigma, and has supported Lean Six Sigma initiatives at many Dutch and international organizations.

This course introduces knowledge analytics techniques that area unit usually helpful at intervals Lean Six Sigma improvement comes. it's a five week course and needs sixteen hours to finish. This course can facilitate to find out knowledge analytics techniques that area unit usually helpful at intervals Lean Six Sigma improvement comes. Through this course we tend to area unit ready to analyse and interpret knowledge gathered at intervals such a project. we tend to are going to be ready to use Minitab to analyze the info. It additionally concisely explains what Lean Six sigma is.

It emphasize on the utilization of data analytics tools and therefore the interpretation of the end result .It uses many alternative examples from actual Lean Six Sigma as an example all tools.

The setting they decided for information model is a Lean Six Sigma improvement venture. Anyway information investigation devices are broadly appropriate. So we will find that we will learn procedures that we can use in a more extensive separating from progress ventures.

OBJECTIVES OF THE COURSE :-

- To analyze, process and interpret data.
- To make a problem measurable.
- To choose acceptable tool for knowledge primarily based testing.
- To emphasize on use of data analytics tools and interpretation of the end result.
- To learn techniques that may be utilized in a broader isolating from improvement comes.
- To illustrate all the tools by victimization many various examples from actual lean six sigma project.

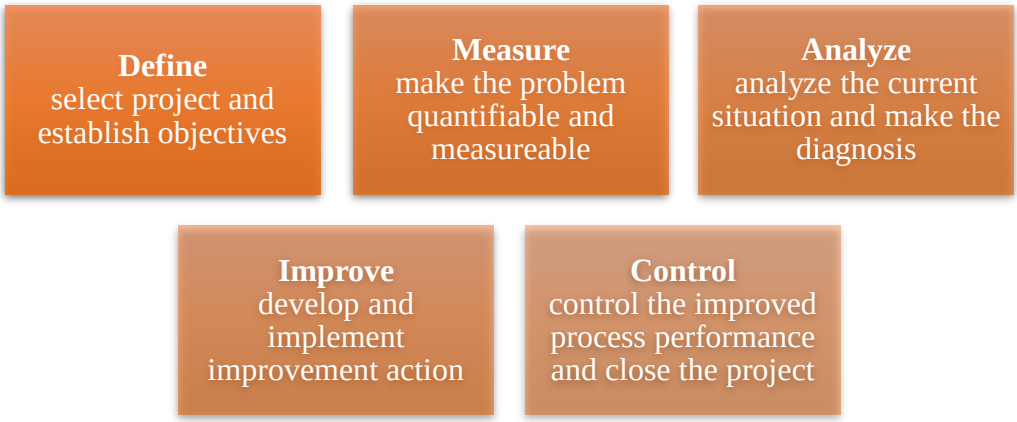
COURSE CONTENT :-

1. Data and Lean Six Sigma

This module introduces Lean Six Sigma and shows you wherever data and data analytics have their place at intervals the DMAIC framework. It additionally introduces the code package Minitab. This package is employed throughout the videos for data analytics.

Introduction to Data Analytics for Lean Six Sigma - Process improvement is important to organizations and Lean Six Sigma is a popular method to do this. Processes are a series of actions or steps taken to make a product or deliver a service. So main features of Lean Six Sigma are it's evidence based and that it makes use of process data. Data is important when you want to improve your processes.
Data can help you to find the biggest problems. Diagnose the current processes or to investigate the effects of your improvement actions.

Data and DMAIC- Lean Six Sigma offers a roadmap known as DMAIC or D-M-A-I-C. These five phases proscribe a step wise procedure for process improvement based on measurements, and evidence based improvement actions. Hence, data and data analysis is very important in any DMAIC project.
The D here is for Define.
The M stands for Measure, A for Analyse , I for Improve, and C for Control.



CTQ - Critical To Quality characteristics, is a Lean Six Sigma terminology. It is a property of a product or a service that is relevant to your project objective. What we want to change determines our CTQ. In statistics and other fields, this variable is called your Y-variable, the dependent variable, or the outcome variable.

Units - are people, objects or phenomena you collect data on. These are sometimes referred as units of analysis, as cases, or as subjects. It can be experimental units, observational units and measurement unit which is sometimes referred to as the unit of measurement. The measurement unit defines what a measurement means.

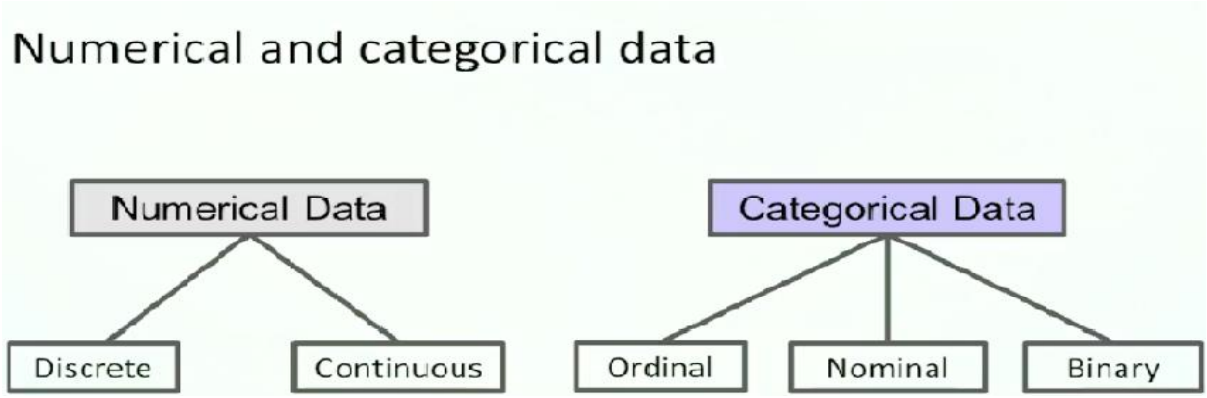
Sampling - It is important to select a representative sample. One way to obtain a representative sample is by randomly selecting the items with help of computer.

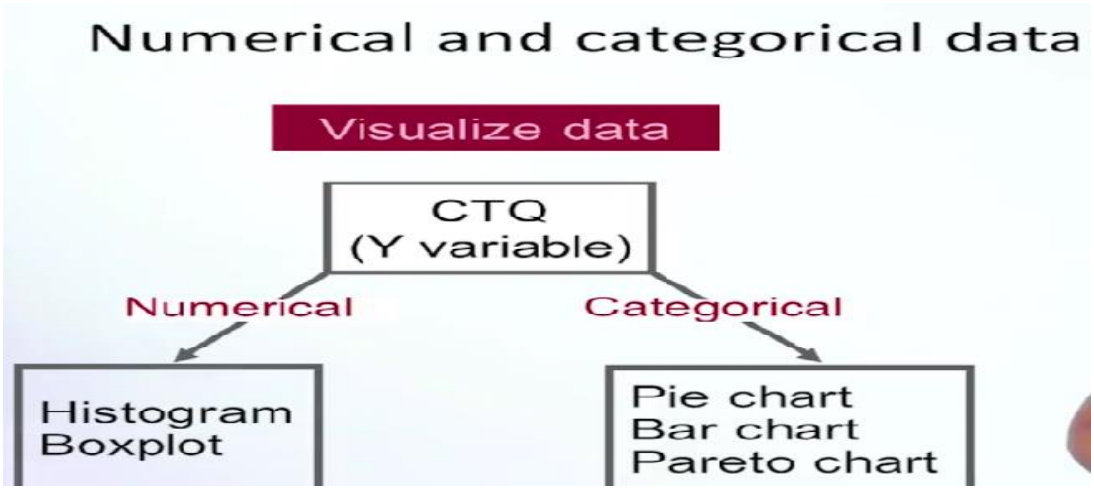
Organizing the data - The dataset consists of units and variables. The rows represent the units and columns represent variables. The units are referred to as observational experimental units or case and measurement unit is required to understand a data value.

2. Understanding and visualizing data

This module explains a way to visualize information. It discusses visualizing single variables further as visualizing 2 variables. you may learn to pick the acceptable graph. For this it's essential to 1st learn the excellence between numerical and categorical information.

- **Numerical and Categorical data and Visualization** There are two types of data:
- Qualitative data (Categorical)
- Quantitative data (Numerical)



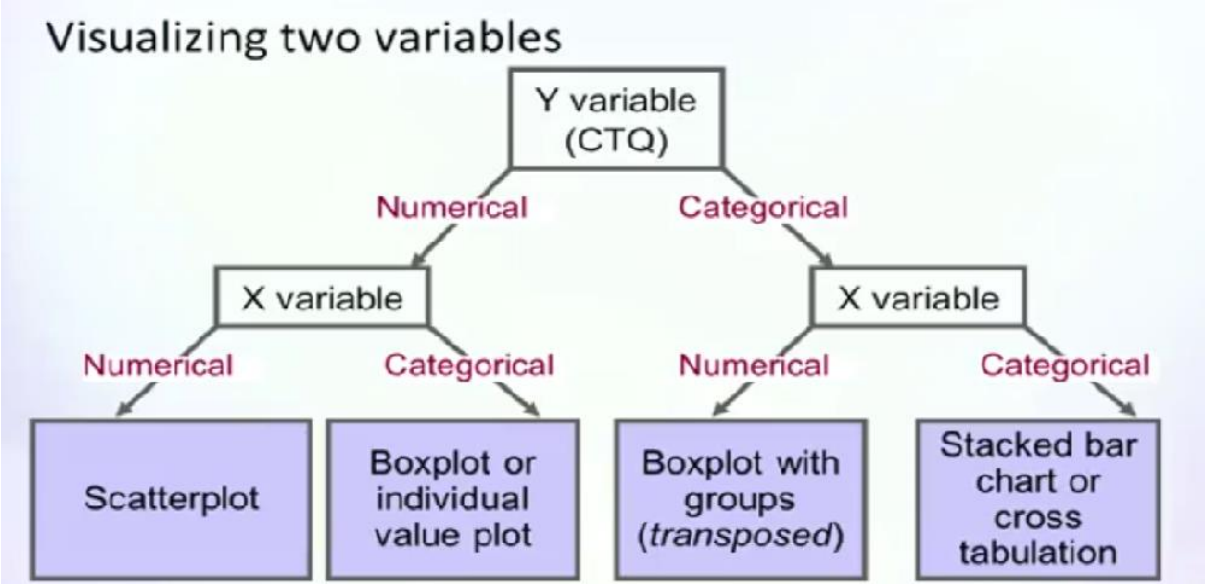


- **Descriptive Studies** are based on mathematical operations like addition and multiplication. However, there is always a certain degree of variation or dispersion in the data. A low amount of dispersion means that most failures are rather close to the mean. A high amount of dispersion means that most failures are quite far away from your mean and spread out over a larger interval. To measure dispersion we look at the **standard deviation**. As these deviations are both positive and negative, their average will be approximately zero. So, to solve this problem, we square the distance first because squaring will give us positive numbers. The average squared distance is called the **variance**. Taking the square root again will give us the standard deviation.

In some cases, the **range** is used to indicate dispersion. It is the difference between the highest and the lowest value, or your maximum and your minimum. Therefore, the distance between Q1 and Q3 is more often used to quantify dispersion, and is called the **interquartile range**. It is less susceptible to the influence of outliers. The mean and the median say something about the location of data and the standard deviation, variance, range and interquartile range say something about the dispersion in your data.

- **Pareto analysis** It is a 80/20 principle. Only a few issues cause the majority of the problems. However, it will never be exactly 80 and 20%. Pareto chart can help to distinguish the vital few causes from the trivial many. We can do this, either by counting the number of occurrences, or by weighing them with the relevant characteristic.

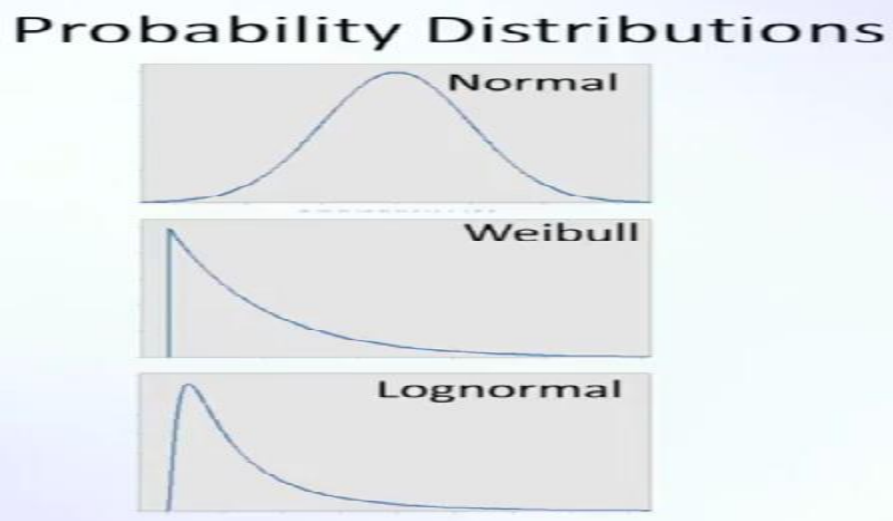
- **Visualizing two variables**



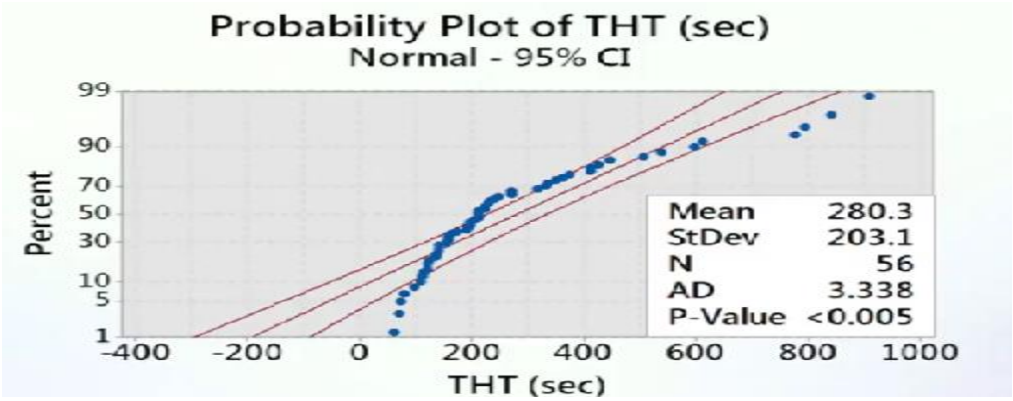
3. Using probability distributions

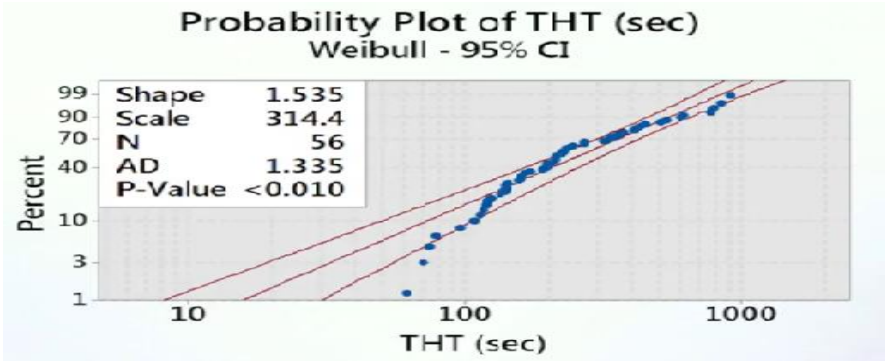
In this module on utilizing likelihood disseminations, you will figure out how to measure vulnerability. Moreover you will figure out how to respond to a significant business question: "what level of items or cases meet our details ?".

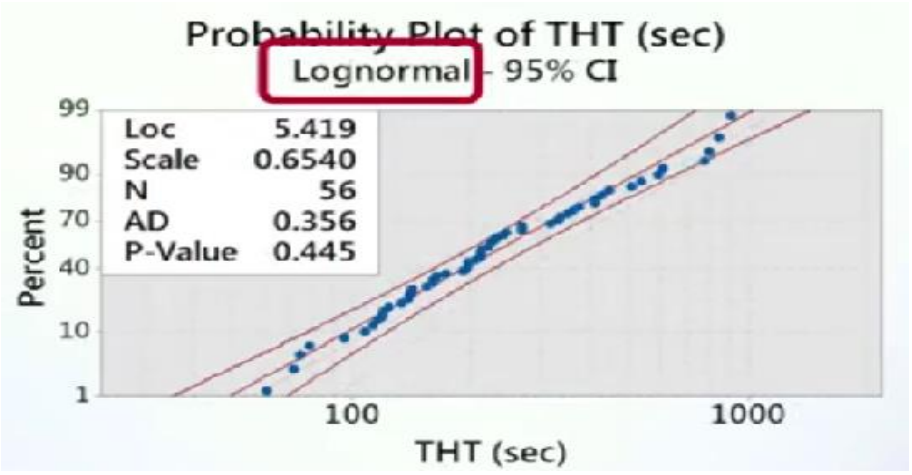
Population versus Sampling A population is a collection of all units of interest whereas a sample is a subset of the entire population, used to say something about the population. Estimation and confidence intervals We use estimates to approximate an unknown population parameter. These estimates will never be exactly equal to the population parameter because it is based on sample. Therefore, to quantity the uncertainty around the estimate, we calculate confidence intervals. A confidence interval gives you boundaries in which a population parameter will lie with a certain level of confidence.
Normal, Lognormal and Weibull distribution



- **Probability plot** A probability plot can be used to find a theoretical distribution that fits best to your data. To check if the distribution fits well, we have to look at the measurements, the dots, are on a straight line, and as much as possible between the two outside lines. The middle line presents the normal distribution. If many data points deviate from a straight line, and do not fall between the two outside lines, then we call it a poor fit. If the data lies more or less on the straight line, and many of the points lie between the two outside lines, we call it a good fit. If you compare all three graphs, you can conclude that a lognormal distribution fits best to your data of THT. As a second check, you can compare the AD values, this is the Anderson Darling statistic. It measures the distance between your data and the theoretical distribution, such as the normal, Weibull, or lognormal distribution. The lower the value, the better the fit. So we select the distribution with the lowest AD value. In this case, the lognormal distribution has a lowest AD value and therefore fits the data best

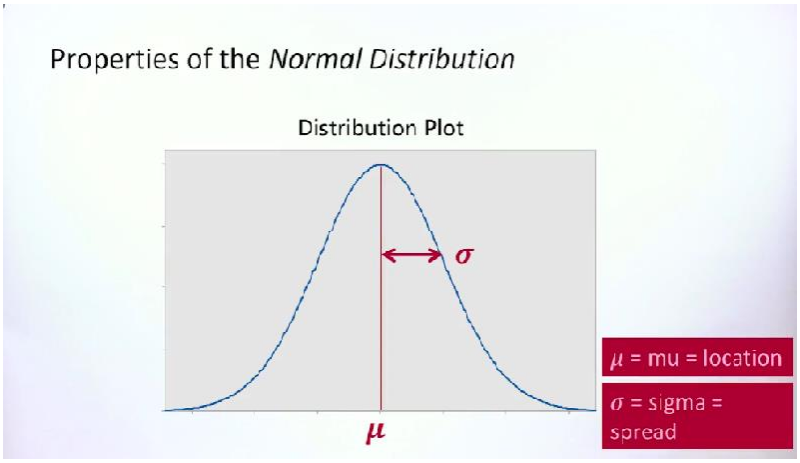




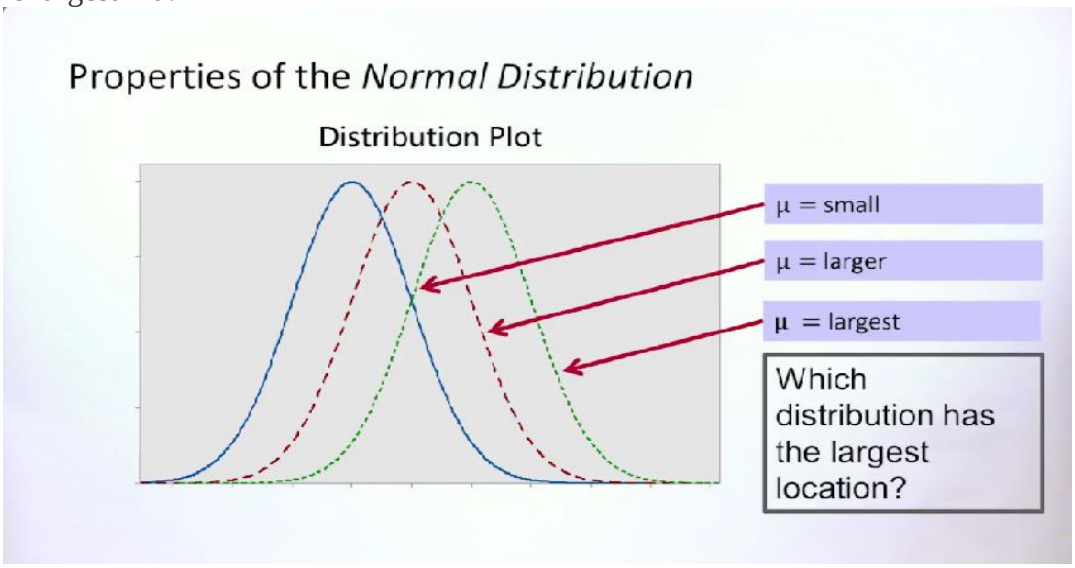


- **Empirical CDF** We can use the Empirical CDF to calculate percentages. You can use the crosshair function or the percentile lines to find the exact percentages. The Empirical CDF is a useful tool in the analyze phase of Lean Six Sigma project.

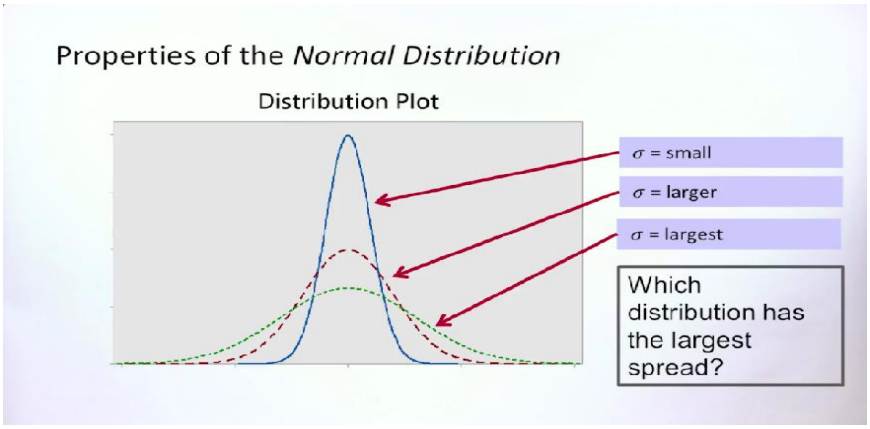
- **Properties of Normal Distribution** A Normal Distribution has two parameters that determine the shape of its distribution. The first parameter is the location parameter which determines the midpoint. This is denoted by mu, which is the location or mean. The second parameter describes the shape of the distribution and is known as the dispersion parameter, denoted by sigma and it determines the spread of the distribution.



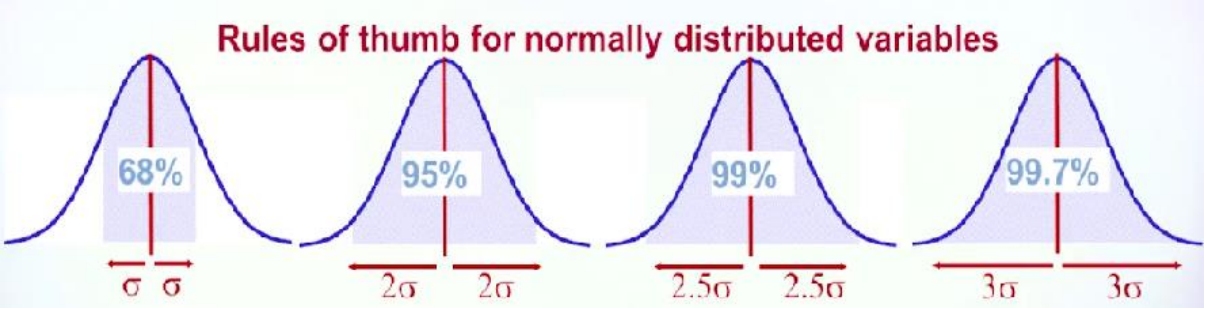
Between these three normal distribution, it is the distribution that is situated most to the right,
has the largest mu.



Between these three Normal Distributions, it is the distribution where the graph is flattened out the most shows the largest spread, the largest sigma.



A variable that is normally distributed will always be, for 68% of the time, in between the new mu plus 1 sigma and minus 1 sigma. Equivalently, 95% of the population will be in between plus and minus 2 times sigma. You might know this rule from the 95% confidence intervals. 99% of the population will be in between the mean and plus 2.5 times the sigma and minus 2.5 times the sigma and 99.7 % will be in between plus and minus 3 times sigma. These can be used as rules of thumb for calculations of a variable that is normally distributed.



4. (a) Introduction to testing

You will learn to model your CTQ and influence factor(s) and to use a choice tree to pick out the suitable tool for knowledge primarily based testing of this model. what is more, causality is introduced .

- **Introduction to Data Analysis** To analyze if two variables are related, you have to determine which variable is your influence factor, or your X variable, and which variable is your CTQ, or your Y. Next, you have to determine whether your variables are categorical or numerical. Once you have determined what type of data you have, the tree diagram can be a very useful tool to determine which type of analysis method is suitable for your data. And these are the methods that you can use for that data-based testing of ideas and improvements in your Lean Six Sigma project.
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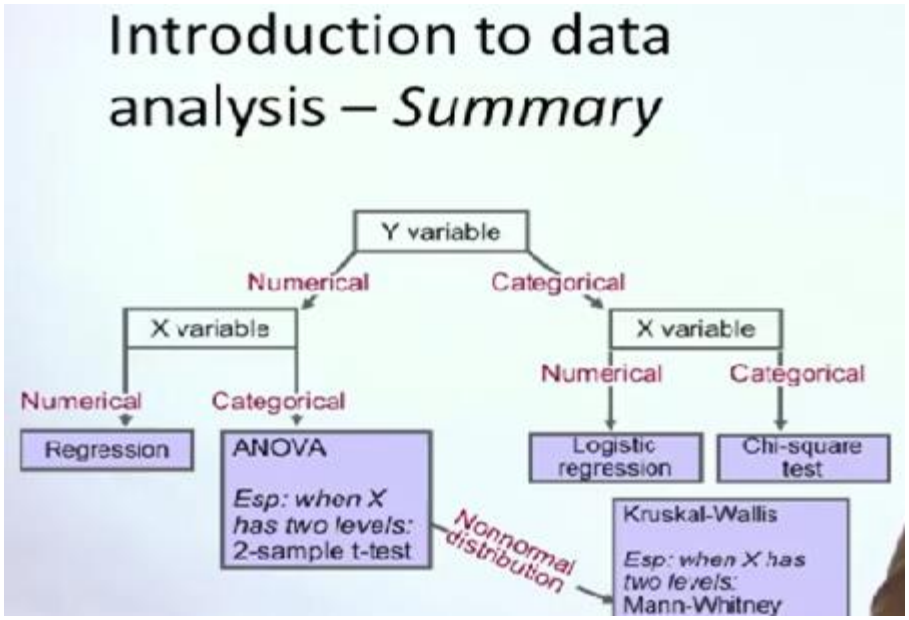
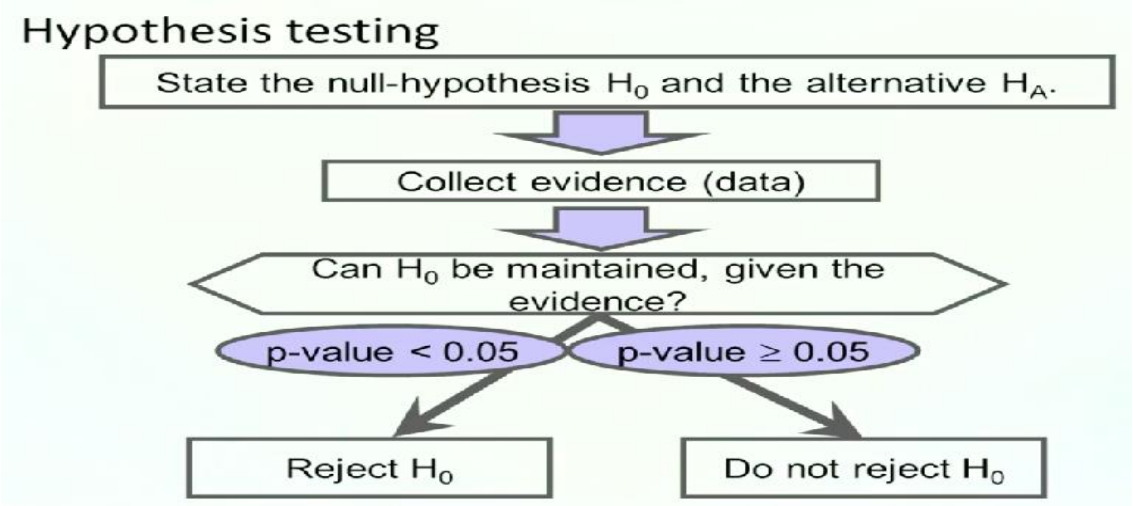


- **Hypothesis Testing** is a procedure to arrive at a decision as objectively as possible, while dealing with uncertainty in a rational manner. Testing means that we claim something and we use data to test this claim. This claim is called a hypothesis. We start with constructing the hypothesis, then collecting the data and finally, drawing the conclusion



- **Causality** Correlation does not imply causation. Correlation means that two things move in the same direction. Whereas causation means that the one thing causes the other to change. It's about cause and effect relationships. This means when you change your X variable and nothing else your Y variable will change as a result. There are four different types of errors that can make us assume causality. These can be:

  - a causal relationship in the wrong direction.
  - can relate two variables to each other that are actually unrelated but change the same way over time.
  - can have a third variable that causes two variables to change at the same time.
  - an underlying variable which is actually the cause of the changes in Y instead of your initial X variable.

b) Testing: numerical Y and categorical X

INTRODUCTION - This module focuses on applied mathematics testing and the way to determine relationship between a numerical Y variable (the CTQ) and categorical influence factors (the X variables).

ANOVA Analysis ANOVA stands for Analysis of Variance and ANOVA is the appropriate statistical technique when the Y variable is numerical and the X variable is categorical. It is a suitable statistical method if you are comparing means across various groups. The analysis consists of three steps, organizing your data, performing the ANOVA, and performing residual analysis just to check if the assumptions are met. ANOVA consists of three steps:

1. Organize the data
2. ANOVA
3. Residuals

The p-value tells us whether the difference between the means of the machines are significant, meaning, that are these differences real and not due to random fluctuations. The R squared tells us how relevant the effect of the machines is. To make sure that the conclusions in your second step are valid, we will have to perform a residual analysis.

- **Kruskal -Wallis Test** is a non-parametric test. This means that there is no specific distribution assumed on the residuals. Of course, if you let go of assumptions, this test will be less powerful than the ANOVA analysis. This means that you basically need more data to show the same difference. This test should be performed when the underlying assumptions of the ANOVA analysis are not met. To interpret the output, you have to look at the medians for each group and of course, add the P-value to see if this difference is statistically significant.

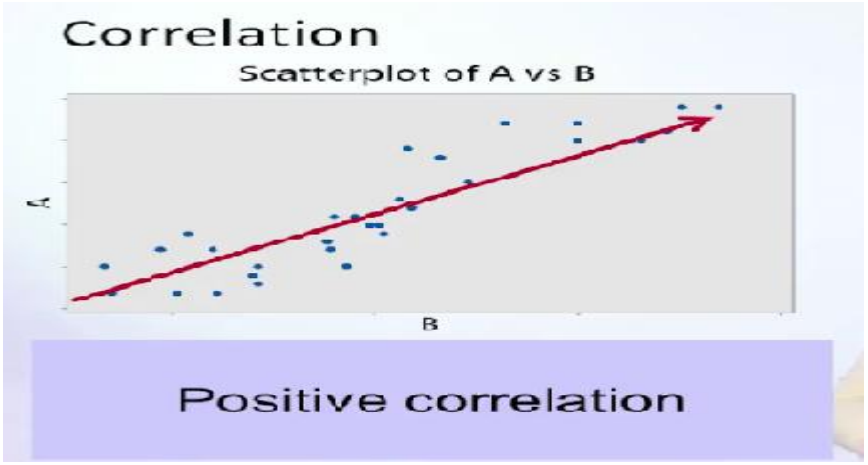
- **Two sample T-test** is also known as a student's t-test. It is a method to compare means of two groups. The p-value can be used to calculate whether the differences of the two mean is coincidental, or truly significant. Especially for small samples this is very useful.

- **Test for equal variances**: Increasing variability perpetually degrades the performance of a production system. this can be the law of variability. It shows that understanding variation is extremely vital for the standard of a method. It helps to match variances across teams for equal variances. this information concerning equality of variances is accustomed improve the p-value over and over.

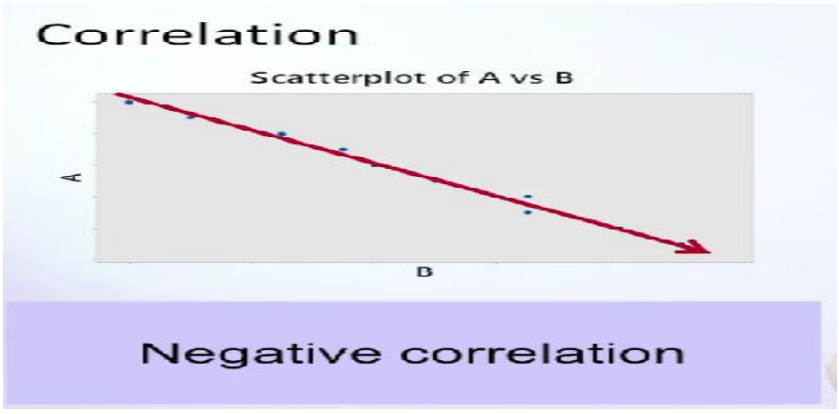
5. (a.) Testing: numerical Y and categorical X

This module focuses on applied mathematics testing and the way to determine relationship between a numerical Y variable (the CTQ) and categorical influence factors (the X variables).

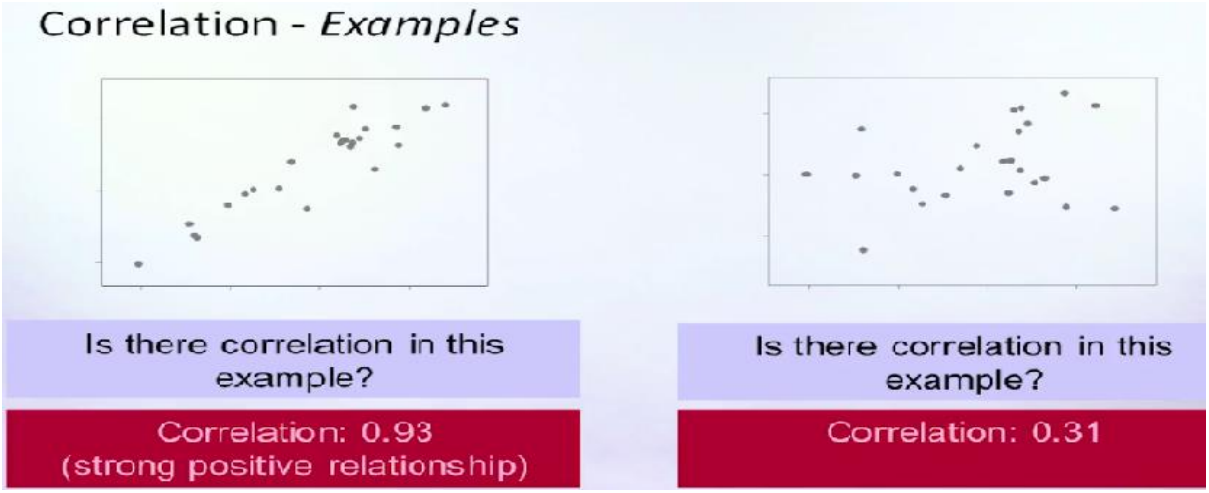
- **Correlation** is an index that expresses how strong a relationship between two numerical variables is. This index is always between minus 1 and plus 1.A correlation of 0 means that there is no linear relationship. For example A and B show a positive correlation. This means that higher values of one of the variables will generally correspond to higher values of the other variables.



Whereas a negative correlation means that the variables are correlated in the opposite direction. So higher values of one of the variables generally corresponds to lower values of the other variable.

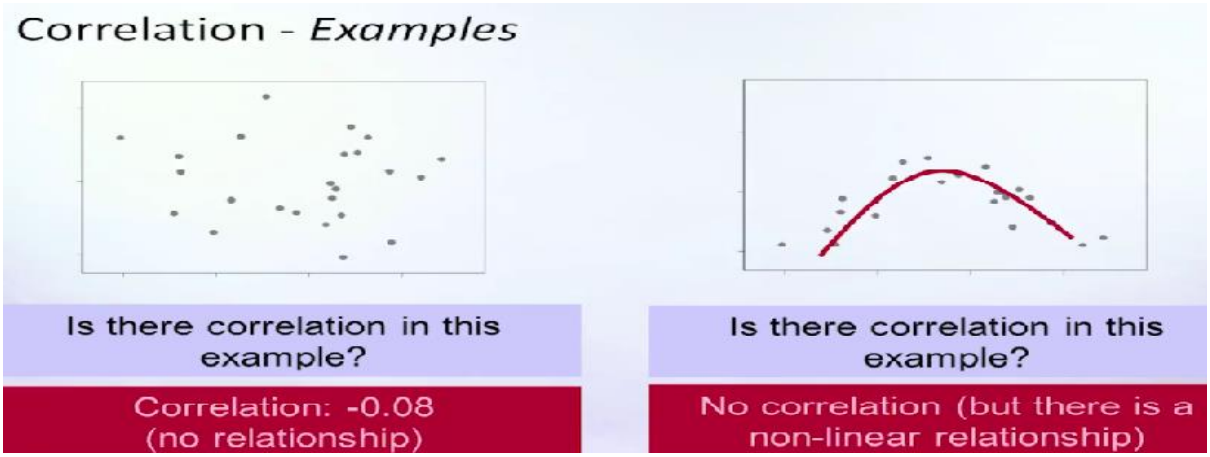


Now, let's take a look at some examples.



Correlation is 0.93 which depicts a strong, positive relationship

Correlation is 0.31 i.e. a weak positive relationship



Here, there is no correlation, it is very close to 0. The observations are just scattered around.

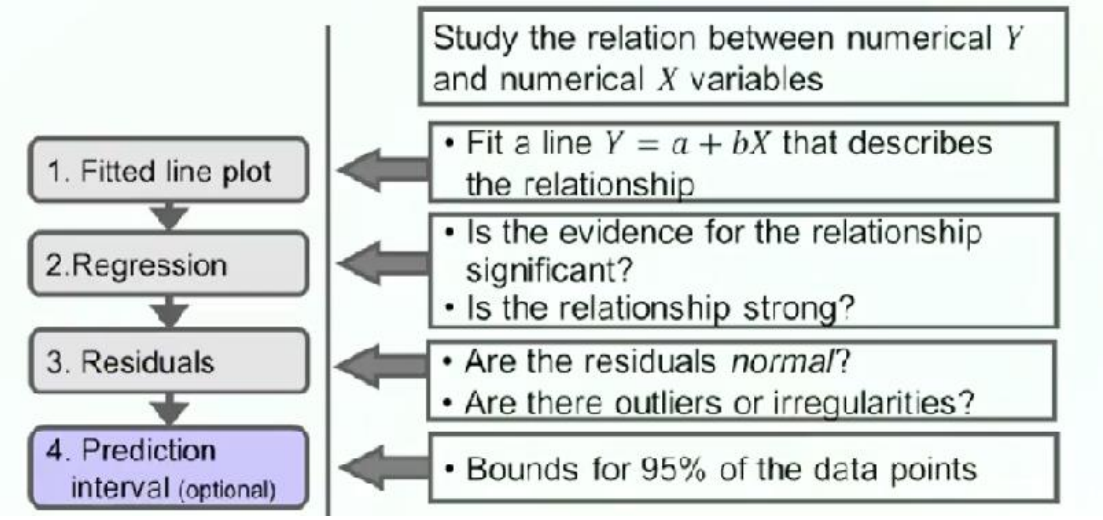
It is a curved (non-linear) relationship. There is no Correlation as it is a linear relationship

Correlation - *Overview*

Rule of thumb:

0 to 0.4	No or weak positive correlation
0.4 to 0.8	Moderate positive correlation
0.8 to 1	Strong positive correlation
0 to -0.4	No or weak negative correlation
-0.4 to -0.8	Moderate negative correlation
-0.8 to -1	Strong negative correlation

- **Regression analysis** is about finding the best fitting linear line for your data. In summary, regression analysis is a statistical method to test if two numerical variables are related by calculating the best fitting line. Regression analysis consists of four steps.



- Thus, the fitted line plot indicates the constant a and the slope b of your line. The formula for the fitted line is equal to the function Y = a + bX. The a represents the constant of the line, which is a value when X equals to 0.
- The p-value indicates whether the findings are due to chance or whether they are statistically significant and the R squared shows how strong the relationship is.
- If you have outliers, a possible way is to delete them and see if the results of your regression change a lot. If the residuals are normally distributed and show no outliers or irregularities, this means that your assumptions are met. Compare your model under both situations. If the assumptions are not met, you have to be careful to interpret your results.
- Prediction intervals are used to make predictions about data that is not in your sample. The prediction interval can be used to determine the level of influence factor, which ensures a certain CTQ performance. We can use crosshairs, or the formula, to determine the required value of the influence factor.

- **Quadratic Regression** If the linear regression analysis does not meet the assumption, you will have to apply an alternative analysis technique. One of these alternatives is the quadratic regression analysis. Quadratic regression makes it possible to study a curved line. This technique fits a curved line to your data instead of a straight line. After performing regression analysis, there is a need to perform the residual analysis again to see if the assumptions are met.

b) **Testing: Categorical Y**

INTRODUCTION Finally we will learn how to test a relationship between a Y and a X variable whenever your Y variable (CTQ) is a categorical variable.

- **Chi-Square Analysis** The two steps of the chi-square analysis are:
  - to make a cross tabulation
  - to take a look at p-value. It shows you whether or not the effect you found is significant

- **Logistic regression** It consists of three steps:
  - In the first step, you may need to convert your data to the correct format.
  - In the second step, you make a fitted line plot and evaluate the quality of the fit.
  - In the final step, you analyze the p-value and see if you have found a significant relationship.

LEARNING METHODOLOGY USED IN THE COURSE :-

Learning methodologies used in this course are mainly videos, reading materials, quizzes. It is an online based learning course of 16 hours with flexible deadlines to refresh the statistical knowledge with the help of video lectures along with the reading material so that we won't miss out anything if we wish to review it again. There are weekly practice quiz and graded quiz to test our learning objectives and self assessment. There are weekly forums where course related problem solving take place. In this module, it also introduced a software package called Minitab which is used throughout the videos for data analytics. Many day to day process improvement examples are also use for a better understanding of the concept. There are some video exercises also which gives us hands on practice for solving the problems.

KEY LEARNINGS FROM THE COURSE :-

WEEK 1: In this week we came to learn about the lean six sigma, Data and DMAIC framework, how to select CTQs, how to perform sampling, organizing the data, the units and operational definition along with installation of Minitab.

WEEK 2: In this week we learn to visualize numerical and categorical data, descriptive statistics, Pareto analysis, visualizing two variables along with video exercises on investigation time and coffee batch.

WEEK 3: In this week we got to know the difference between population and sampling, we learn about estimation, empirical CDF and confidence intervals, normal, lognormal and weibull distribution curves, probability plot and a video exercise on the length of stay.

WEEK 4: In this week we got to learn about data analysis, hypothesis testing, causality, ANOVA analysis, ANOVA residual analysis, Kruskal-Wallis test, Two sample t-test, test for equality of variances and video exercises on productivity and department.

WEEK 5: In this week we learnt way to determine relationship between a numerical Y variable (the CTQ) and categorical influence factors (the X variables), about correlation, regression analysis, regression residual analysis, regression prediction interval, quadratic regression, chi-square analysis, logistic regression and video exercises on picking, printers and students.

THANK YOU