

Part-1
Summer Project
On
Impact of Covid-19 on Environment

A Report

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Acronyms/Abbreviations

1. AFDLHF - All Food and Drug License Holders Foundation
2. ASSOCHAM - Associated Chambers of Commerce and Industry of India
3. AURA - Name of NASA Satellite
4. AQI - Air Quality Index
5. BOD - Bio-oxygen demand
6. BWI - Baltimore Washington International Airport
7. CII - Indian Industry Confederation
8. CPCB - Center Pollution Control Board
9. D&B - Dun & Bradstreet Information Services India Private Limited
10. DO - Dissolved Oxygen
11. ESA - European space agency
12. FAITH - Foundation for Appropriate and Immediate Temporary Help
13. FICCI - Federation of Indian Chambers of Commerce and Industry
14. FY - Financial Year
15. KPMG - Klynveld Peat Marwick Goerdeler
16. LPG - Liquefied Petroleum Gas
17. MGNREGA - The Mahatma Gandhi National Rural Employment Guarantee Act
18. MoHFW - Ministry of Health and Family Welfare
19. NASA - National Aeronautics and Space Administration
20. NIFTY - National stock exchange fifty
21. NSE - National Stock Exchange
22. OMI - Ozone Monitoring Instruments
23. SEBI - Securities and Exchange Board of India
24. SENSEX - Stock Exchange Sensitive Index
25. SIDBI - Small Industries Development Bank of India
26. TROPOMI - TROPOspheric monitoring instrument

ABSTRACT

Introduction: In late December 2019, a novel infectious coronavirus disease, Covid-19 identified in Wuhan, China which was caused by a new member of the coronavirus family named as SARS-CoV-2. The disease was epidemic in China, after spreading in other countries (around 182) of the world including India, it became pandemic. In India, the first case of Covid-19 was confirmed on 30 Jan 2020. On 24 March, PM Narendra Modi announced a complete lockdown of India for 21 days, a primarily initiative taken to stop the spread of coronavirus which has human to human transmission characteristics.

Aim: This research aims to analyze the positive and negative impacts of Covid-19 and the lockdown on the environment. To know the impact on human health and their behavior with economic decline, and on animals as well.

Methodology: In this research, the initial steps taken like studying various articles about the impact of lockdown amid covid-19 and also reading research papers to collect data and experimental results. The Gathered information about the impact of covid-19 on the environment, humans, animals and economics organised in a proper way.

Findings: The positive results which have been seen during the lockdown are, reduction in pollution due to ramping down of social and economic activities of humans and the wildlife animals experienced freedom while roaming on the road freely. Restrictions in road and air transport played an important role in reduction of NO₂ emission. Air quality changes with reduced NO₂ emission. Shutdown of Industries helped in water pollution reduction. Negative results which have been seen are health crisis and economic disturbances as the drastic effect of Covid-19 and the lockdown. Other than being a serious threat to human health, Covid-19 became a major factor for decline in the economy and severely triggered the mental health of people.

Suggestions: So, with the increasing severity, people are advised to take preventive measures for covid-19 and these measures should be adopted in their normal daily life as new habits which we call it as new normal in one's personal life. Wearing masks while going out from home and when coming back home people need to bathe and wash their clothes. Washing

hands and using sanitizer frequently to maintain hygiene and maintaining social distance to reduce infection. People should learn and adopt new ways of living like working from home using digital platforms. This pandemic made people realize that changes in lifestyle can lead to more positive effects on the environment.

Introduction

In the end of December 2019, a new infectious disease was detected at Wuhan, China and the initiating agent found was SARS-CoV-2 (Severe acute respiratory syndrome coronavirus-2). Mode of transmission identified as human to human, spreading through respiratory droplets, confirmed by WHO in January 2020. Cases were increased rapidly in Wuhan and spread all over the country of China and became an epidemic outbreak. To overcome this situation, China imposed the total lockdown to stop the spread of coronavirus and to reduce the burden of outbreak on health facilities where lockdown included shutting down of public transport, industries, offices, schools, colleges, parks and social interaction places. On 30 Jan, WHO announced a global public health emergency. On 11 March 2020, the outbreak spread to other countries in the world and WHO announced it as pandemic. First case of Covid-19 in India was confirmed on 30th Jan in Kerala. Within one month after reporting the first case in India, cases started increasing which led the government to apply the strategy of lockdown. On 16 March, all educational institutes shutdown. India saw the Janata Curfew declared by PM Narendra Modi on 22 March. The Prime Minister also called a national lock-out for 21 days on 24 March. The pm extended the country's lock-up to 3 May on 14 April, with additional lock-down extensions until 17 May.

It was found that SARS-CoV-2 has more than 60% similarities to the SARS virus caused outbreak in 2003. The number of cases shows that individuals of all ages will get the Covid-19 disease, but the risk of becoming seriously ill is obviously higher than age 60. Those with pre-existing non-communicable diseases (in particular, hypertension, diabetes and cardiorespiratory disease) and smokers are more vulnerable to Covid-19. Pulmonary system with other important organ systems, such as heart, brain, liver, and olfactory systems are most affected by the virus. To stop the spread of coronavirus, various safety measures are advised like using masks and sanitizers, washing hands frequently, maintaining social distance and the

complete lockdown. This lockdown causes positive and negative impacts on the environment. Negative impacts include health crises which includes the death due to Covid-19, suffering from the disease and psychological stress caused by the death of family members or friends. Financial crisis, mental health disturbances, stress, anger, anxiety were the results of lockdown where job losses led to the first concern. Moreover, the Indian economy is affected badly.

Lockdown brought people closer and spending time with families was another positive and wonderful impact of Covid-19. As human activities were negligible, animals found the place to roam peacefully and freely. Industrial facilities and power plants halted their production. Road and air transport decreased considerably due to these people staying at home and working from home. Use of vehicles were reduced because people were not allowed to travel. All this led to reduction in pollution because all industrial and manufacturing companies and transport sectors came to halt. Reduced transport activities resulted in less energy consumption hence lowered oil demand. Combustion of fossil fuel is responsible for NO₂ (nitrogen dioxide) emission. Road and air transport is a major source of NO₂ emission. NO₂ is a highly lethal pollutant that causes air pollution. Lockdown helped in reduction of air pollution. According to the estimates of NASA and ESA, NO₂ emissions were reduced to 30 percent and air quality improved. NASA gathers data on its AURA satellite via OMI (Ozone Monitoring Instrument) and ESA collects data via TROPOMI.

Industrial shutdown and reduced human activities leads to reduction in water pollution. Water bodies were in poor state before the lockdown, several plans imposed to clean the Ganga river but never had any positive impact on quality improvement. During lockdown, the Ganga became fit for drinking water at Rishikesh and Haridwar as 27 points showed the improved water quality fit to bathe and disseminate wildlife and fishery from 36 real-time water quality monitoring stations. Dolphins spotted near Kolkata ghats as the river is cleaner than ever before. Animals have freedom to move anywhere which they never had before the lockdown. In Navi Mumbai, tens of thousands of flamingos were seen. All these concluded the positive side of the lockdown.

Literature Review

A study done to relate the effects of lockdown amid Covid-19 on improving quality of air, water and noise. Study shows positive and negative impacts of Covid-19 on earth. Work by Kaiser shows how COVID-19 bans on travel and lock-out orders affect air quality at airports. “Airports are usually some of the hottest spots for nitrogen dioxide,” Kaiser said. As we burn fuel on aircraft or in vehicles, nitrogen dioxide is released. Exhaust from the airplane also absorbs formaldehyde, an indication of the production of ozone and another pollution toxin. Airport measurements have shown a decrease in air traffic. Joiner and Duncan also report lower rates in nitrogen dioxide in the air on a global scale at NASA Goddard.^[2]

In one of six big air contaminants (in addition to particulate matter, carbon monoxide, sulfur dioxide, ground-level ozone and plumage) the experts used satellite imagery to quantify nitrogen dioxide (NO₂). NO₂'s natural origins include flares, rivers and volcanoes. Flugzeuge, power plants and boats all burning fossil fuels are important sources of human NO₂. Copernicus Sentinel 5P satellite imagery from the European Space Agency tests low NO₂ levels when locking.^[3]

The study showed data for 34 monitoring stations distributed across the Delhi megacity, including the seven contaminants (PM₁₀, PM_{2.5}, SO₂, NO₂, CO, O₃ and NH₃). In comparison with the pre-lockdown period, PM₁₀ and PM_{2.5} concentrations showed maximum decrease (> 50%) in the selected air quality index (NAQI). NO₂ (– 52.68%) and CO (–30.35%) levels were also decreased during the lock-down period, among other pollutants. Air quality improvement is observed during lockdown at approximately 40 % to 50%. In northern, eastern, southern and western parts of the megacities of Delhi, about 54 percent, 49 percent, 43 percent, 37 and 31 percent decrease is observed in NAQI.^[6]

A study shows that the lockdown period became a gift to the Ganga river. The Ganga water quality improved significantly during the lockdown period. Before the lockdown river was in poor state, it was a dumpyard for industrial and sewage waste. According to the CPCB report, most of the Ganga stretches in Uttar Pradesh to the West Bengal were found to be not only in breach of the standards of drinking water, but recorded much less oxygen dissolved and high

total coliforms (human and animal waste bacteria). After lockdown, because of no water lifting by industries and no water withdrawing by the agriculture sector due to harvesting season, more flow was in the river and pollutants got dissolved. Also less economic and industrial activities led to water quality improvement^[7].

Study done to show the impact of Covid-19 on Indian economy. This study shows the variation of economic impact in different sectors, states and social groups. The World Bank published its Global Economic Prospects Report which notes that India will be 3.2 percent lower than its Gross Domestic Product (GDP) by 2020-21 and a 3.1 percent rise recovery by 2021-2022. Contracting GDP means losing jobs where one's income falls. There will be no contraction in two sectors: agriculture and industry. A share 85 percent of Gross State Value Added (GSVA) for Delhi was kept by the non-farm, NGO market. This share for Madhya Pradesh was 56%, and for Arunachal Pradesh it was just 38 percent. It means the economic suffering of Delhi would be even greater than that of Arunachal Pradesh. Construction is a work-intensive sector rather than funding because of construction's share of 8% in GVA and 12% in employment whereas finance's share in GVA is 22% and only 3.4% in employment. So it means job losses will be more in the construction sector than the finance sector. Due to lockdown, in the transportation sector which accounts for 60% of oil demand, resulted in a decline in oil prices^{[8][10]}.

A study done to show that the lockdown amid Covid-19 severely affected humans in numerous ways. Every person got affected in some or other ways by various degrees of suffering. From fear of infection to illness caused psychological stress and death of family members or friends caused emotional stress. To help avoid the spread of COVID-19, factories were shut down, where the economic and mental stress were exacerbated by financial problems and loss of jobs. Self-isolation caused frustration and anger during the lockdown, while tension and anxiety triggered more alcohol abuse and sexual and physical violence.^[12]

In a study it has been seen that lockdown not only displayed positive effects on the environment but also had dramatic impacts world-wide on wildlife. From the stoppage of global wildlife trade to the ban of their consumption and production, demand in the animal husbandry market also declined. Lockdown also played a major role in the privacy of zoo animals when there were no humans. Different animals are spotted at various places across the

world while roaming freely on the road, without human disruptions. Animals visited the places where they never dared to go before the lockdown^[19].

Methodology

This research targets the impact of covid-19 on the environment. In research, looked through various articles and research papers to collect data and experimental results. Covered three major components of the environment: Water, Soil and Air. Also covered the impact of covid-19 on animals and humans as they are also part of environments. And since the economy and environment are connected, our research also covered the impact of covid-19 on the economy as well.

Analysis Framework

1. Reading various articles about the impact of covid-19.
2. Gathering information about the impact of covid-19 on the environment, humans, animals and economics.
3. Summarizing collected information in an organized way.
4. Concluding based on the collected information.

Rationale of the study

This research is one stop shop to understand the impact of covid-19 on environments, humans, animals and economics. In this research, we are trying to go through various articles and research papers to cover the impact of covid-19. And then summarizing the vast information from those papers and articles in this report. At the end, concluding what will be the new norms with covid-19, what are the learnings and how to respond to pandemic like this if it happens again in future.

Objectives of the Study

- To study the impact of lockdown on the environment.
- Dive deeper to understand the impact of lockdown on positive and negative effects on air and water pollution.
- To know the impact on human health and their behavior. To analyse how a new member of the coronavirus family became a serious threat to health.
- To understand the impact of lockdown on wildlife animals and their freedom to live on the natural front without any human disturbances.
- To cover the impact on various economical factors due to Covid-19 and lockdown. And how the economy plays an important role in the environment.
- To know about the new normal and the learnings. To analyse how Covid-19 and its impact can open a new paradigm of living.
- To give suggestions on how to respond if this kind of situation happens again.

Impact of Covid-19 on Environment

"The most notable results are cleaner air, cleaner water, less pollution, exceptionally low levels of rushing and visibility of hidden wildlife"

Prior to the World Environment Day on 5 June, researchers highlighted many environmental issues, including air pollution, noise pollution, water pollution and biodiversity, which strengthened Indian environmental conditions due to the lockdown. On 24 March, the government of the Union ordered the lock-up of the citizens in India for 21 days as a preventive measure to tackle the COVID-19.

Slowing down of human activity shows a positive impact on the environment. Emissions and effluents from manufacturing and transportation have declined and observable evidence supports the elimination of air, soil and water contaminants. Lockdown steps cannot only minimize emissions, but may also affect future monsoon. Atmospheric aerosol is crucial in setting a monsoon start date and distribution of rainfall in India.

Another indication of a cleaner environment was found when on 3 April, Jalandhar, a town in the state of Punjab, woke up to the view of the Dhauladhar mountain range, which was a remarkable feat in normal times, taking into account the distance of the two places-almost 213 kilometers apart and not visible from the town in recent times.

1. Impact of Covid-19 lockdown on air pollution

Air standard in India was greatly improved due to the COVID 19 lockdowns. On average, the concentrations of particulate matter over the southern part of India were decreased by about 50-60%, and over the Indo-Gangetic part like Delhi, UP, Bihar, and western Bengal, was up to 75%. Transport vehicles, industry, crop residues, waste burning and so on all contribute mainly due to pollution. The amount of vehicles on the road was significantly reduced in the lockdown. The levels of nitrogen dioxide were also decreased drastically. In India, satellite data demonstrated a substantial decrease in particulate matter or aerosol (which are the major component of air pollution) after COVID-19 lock-down over most parts of the world.

A) Air quality changes in New Delhi, Mumbai

In May 2014, the WHO ranked New Delhi as the world's most polluted city. According to the air quality index, the average air quality of the country's national capital was 200. When pollution reached its peak, the level of pollution rose to 900 at times and out of measurable proportions. After lockdown, AQI levels have regularly fallen below 20. The government statistics in the New Delhi capital show that the average PM_{2.5} concentration fell by 71% over the space of one week (March 20-March 27) — from 91 $\mu\text{g}/\text{m}^3$ to 26 $\mu\text{g}/\text{m}^3$. Pollution rates dropped the most significantly in the urban areas of Delhi. NO₂ rates were averaged by 90 $\mu\text{mol}/\text{m}^2$ between March 25 (quarantine started)-May 2 and 162 $\mu\text{mol}/\text{m}^2$ between 1 March-24 March. But last year, NO₂ levels averaged 158 $\mu\text{mol}/\text{m}^2$ between 25 March-2 May.

A similar pattern was observed in Greater Mumbai and Navi Mumbai with NO₂ levels of an average of 77 $\mu\text{mol}/\text{m}^2$ between 25 March and 2 May compared with 117 $\mu\text{mol}/\text{m}^2$ between 1 March and 24 March. NO₂ levels averaged 122 $\mu\text{mol}/\text{m}^2$ between 25 March and 2 May 2019. Similar decreases in rates of NO₂ are evident in nearly all other major Indian cities, highlighting India's national lockdown.

B) Air quality changes on global level

At airports, aerial traffic reduction is noticed. Nitrogen oxide seems to have a major effect because it is released after burning of fuel which is used in airplanes or in vehicles. In the environment where people respire, the nitrogen dioxide released reacts with other substances and ozone forms. Formaldehyde, an indicator of ozone formation and a further air toxin are also used as aircraft exhaust.

For the study of air traffic at the BWI (Baltimore-Washington International Airport) and Hartsfield-Jackson Atlanta International Airport, two sensors were installed with the spectrometer which identifies chemicals in the air. These spectrometers use ultraviolet and visible light wavelengths for the identification of at various atmospheric altitudes of ozone,

nitrogen dioxide, and formaldehyde. During lockdown, the total BWI traffic has fallen by about 60% and the Atlanta traffic has dropped 70%.

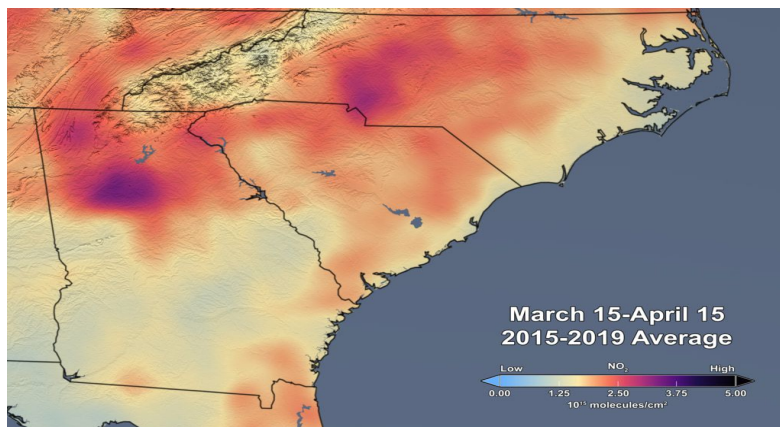


Figure 1: Map showing nitrogen dioxide results before Covid-19 lockdown. Tropospheric nitrogen dioxide column, March 15-April 15 2015-2019 Average, Southeast USA

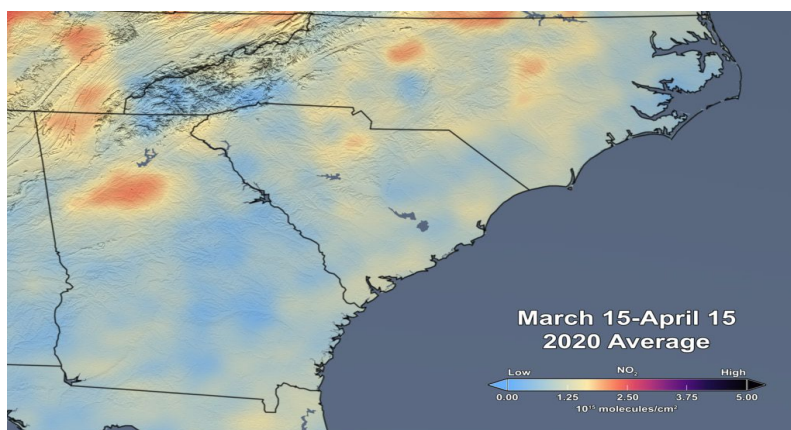


Figure 2: Map showing result of nitrogen dioxide after Covid-19 lockdown. Tropospheric nitrogen dioxide column, March 15-April 15 2020 Average, Southeast USA.

2. Impact of Covid-19 lockdown on water pollution

“Water quality in India was greatly improved due to the COVID 19 lockdown owing to reduced industrial effluents”

During lockdown on the industrial units in Delhi-NCR, the water quality of the Yamuna River was obviously improved as tons of the toxic waste and effluents were not released into it any more. With the industrial shutdown, people's activities were also not there so Ganga River water quality has significantly improved by around 40 to 50 percent.

A) Status of rivers in India

Rivers in India are in a poor condition. Many rivers and lakes have been converted to sewage canals and are difficult to maintain in order to promote economic growth. An estimated 40 million liters of waste water is flowing into rivers and other water sources every day, with a proper treatment of just 37 percent.^[7]

A study from the Center Pollution Control Board (CPCB) shows the country has undergone critical rises in its river stretches, from 302 in 2016 to 351 in 2018. Bio-oxygen demand (BOD) was the basis for this observation. The condition is assessable in terms of the severity by the figures submitted to the National Green Tribunal by CPCB in August 2018. Out of 70 only 5 monitoring stations had drinking water and 7 were bathing water suited.

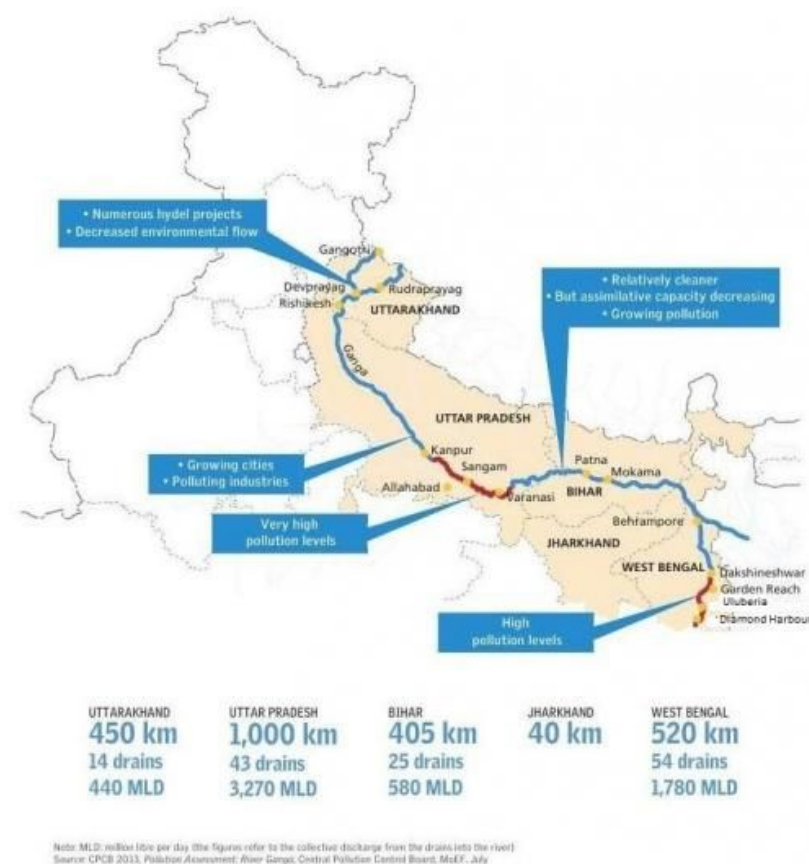


Figure 3: Status of Ganga river in India

B) Status of Ganga in India before lockdown

The river became a wastewater and industrial waste disposal yard. Contribution of domestic sewages in the surroundings towns and villages in Ganga pollution is more than 80 %.. According to CPCB, the treatment plant for wastewater does not meet the drainage requirements. The rest is made possible by industrial waste. The total effluent pumped into the Ganga was approximately 6500-6700 million liters a day (MLD) in the river's UP area and so on. Approximately 10 percent, around 700 MLD, was toxic from industry. The gross BOD was 30% due to industries along the river that were 130-150 tons a day.

Many initiatives and methods for cleaning the Ganga have been implemented since 1985. Following image shows the timeline of different plans for cleaning Ganga. Namami Gange unveiled a budget of Rs 20,000 crore in 2015, the biggest event ever. The Ganga is still polluted despite many programs and large funds.

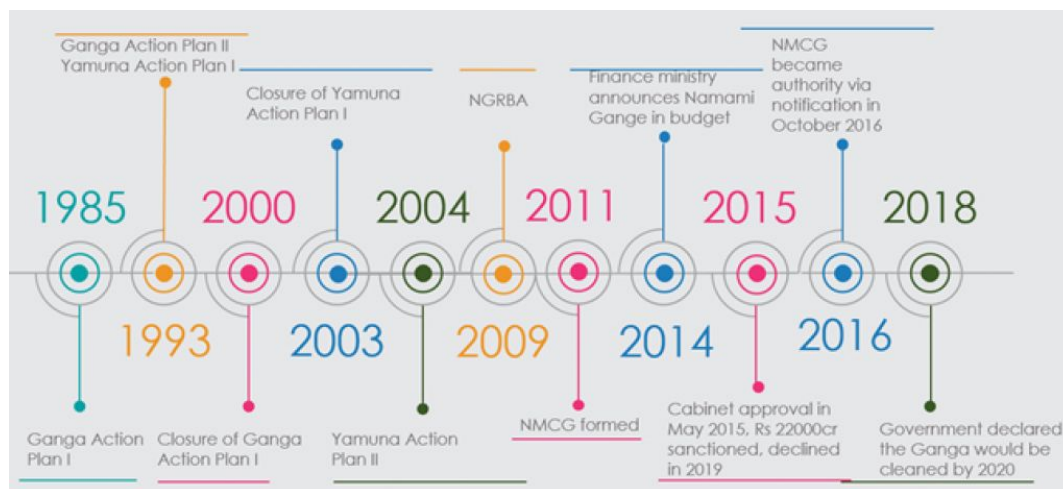


Figure 4: River Ganga action plan from 1985 to 2020

C) Status of Ganga after Covid-19 lockdown

On 25 March 2020, the national lockdown was enforced where polluting industries were closed, the signs of improved water quality began to appear within 10 days. Based on real-time CPCB water monitoring data, water quality at some 27 different locations was found to be sufficient for bathing and fisheries out of 36 water quality monitoring stations established in different points of the Ganga river.

Dissolved Oxygen (DO) values were found in Varanasi's Nagwa Nala on 4 April to have increased to 6.8 mg/l, compared to 3.8 mg/l on 6 March, with an incredible 79 percent rise in DO values. Ganga water was confirmed to be suitable for drinking at Haridwar and Rishikesh due to reduced sewage and industrial wastewater. The biological oxygen requirement for the Ganga was <3 mg/L, the dissolved oxygen was >4 mg/L and pH was 6 to 9 respectively which made its water fit for drinking.

Impact of Covid-19 on Human Beings

“Covid-19: A global health crisis that is killing human beings, spreading human suffering, and reducing the lives of individuals”

The COVID-19 affects all sections of the population and is particularly difficult for the most disadvantaged classes, including the poor, the elderly, the handicapped, young people and indigenous peoples. Early evidence suggests that the health and socioeconomic impacts of the virus impact poor people overwhelmingly. In the absence of shelter, for example, the homeless are highly exposed to the risk of the virus. The pandemic and its effects are also faced overwhelmingly by refugees, migrants and displaced persons with little access to drinking water, irrespective whether they are constrained in their travel, or because of less employment. It is a human, economic, and social crisis.

1. Impact of Covid-19 on human body

The new coronavirus and the infection caused are very recent, according to medical experts and the world. While the SARS virus that triggered an epidemic during 2003 was over 60 percent similar, new research indicates that SARS-CoV-2 is probably smarter than other viruses seen in past times worldwide.^[13]

The pneumonia-like virus described at the beginning is now known to cause serious damage to various vital human body organs and systems. The heart, brain, liver, lungs, olfactory system, feet, etc. The lung continues to be one of the most affected organs, and in many COVID-19 patients, there are frequent irreparable lung damage that causes death. Recent autopsies and research has shown that COVID-19 damage to the lungs varies from damage caused by influenza.

2. Impact of Covid-19 on human behavior and socialization

One of the first human consequences of the pandemic were economic difficulties and work losses. It impacted our economic, physical and mental health from family and friend's death to illness, emotional stress, anxiety, fear and mental trauma that almost all people are facing.

Social distance and lockdown also contributed to altruistic behaviour, partly because of a sense that “we are all in that together.” Some people say that they have been bored or worried about weighing up, others have discovered a slower rate of life and have found more time for families, others and even for their animals by not going out and socializing. Lockdown included, educational institutes shutdown and postponement of examination. The service sector could not provide adequate service and many people lost their jobs. Sports events on a larger scale and the tournaments were cancelled or postponed. All national and international travelling services were avoided. Close up of socially engaging areas such as hotels, restaurants, and theatres, sports clubs, gyms, swimming pools, and the closing of entertainment centres. It has also interrupted the cancellation of cultural activities such as marriage, religious and festive celebrations.

Traumatic stress, frustration and anger are the negative consequences of self-isolation and social restriction; all of them compounded by the fear of illness, limited access to resources, insufficient knowledge and chances of economic loss or stigma. The use of alcohol, domestic violence and family violence can increase stress and anxiety. The social problems created by COVID-19 in the medium to long term can also increase inequality, isolation, and global unemployment. Coronavirus has the impact of the financial and fragile industries such as manufacturing, tourism, hospitality and travel.



Figure 5: Covid-19 domino effect on tourism, travel, hospitality economic and small-medium enterprises

3. Impact of Covid-19 on human life

On 30 January 2020, Kerala posted on COVID-19 for the first time. As of 5 July 2020, 673,165 cases have been confirmed in total by the Ministry of Health and Family Welfare (MoHFW) out of which 409,082 (including 1 migratory) recovered and 19,268 died in the country. India currently has the greatest number in Asia (as of 5 July 2020) and has the third most reported cases in the world after the U.S. and Brazil^[22]. In February only 3 cases were reported. As transmission grew there were 22 cases on 4 March and 1000 cases on 28 March after the four days of lockdown as lockdown was imposed on 24 March by PM. Transmission rate was slow from January to March but it increased with confirmation of approximately 10,000 cases on 14 April and 100,000 cases on 19 May. On 27 June, the number of cases were approximately 500,000. From April to June, the rate of transmission was very high and now it is increasing day by day and reporting more than 20,000 cases per day from the first week of July. As of 5 July, 673,165 cases were confirmed. During the lockdown, the entire nation was divided into three zones – Green Zone, Orange Zone, Red Zone with some terms and

conditions of relaxation. Green zone with least vulnerability to the virus and Red Zone being the most vulnerable to the virus.

Covid-19 generated consumer demand for masks, sanitizers and soaps. Because of high demand, earlier there was acute shortage in supply of masks and sanitizers. The overall market for the mask has swelled to R.S. 450 crore from about R.S. 200 crore annually over the last two months, based on the information shared by the All Food and Drug License Holders Foundation (AFDLHF) which represents some 7000 drug suppliers. In India, there are currently 300,000-400,000 masks with stocks of 2.5-3 millions.^[23] Demand for PPEs, ICUs, Ventilators also is very high with the increasing number of cases. Burden on doctors and other medical professionals is extremely high with the very high risk of getting infection. Overload on police and housekeeping staff is also very high. In diagnosis, quarantine and treatment of suspected or confirmed cases, the health care industries face difficulties. In India, over 5000 railway coaches were converted into isolation units for Covid patients.



Figure 6: Covid-19 isolation coaches. Source: All information from Indian Railways

Impact of Covid-19 on Indian Economy

The economic effect of the viral corona pandemic in 2020 was extremely damaging in India. For the fourth quarter of the financial year 2020, Indian growth fell to 3.1%, says the Ministry of Statistics. The CEO of India, the decline is primarily due to the pandemic impact on the Indian economy of coronavirus. There has also been a pre-pandemic fall in India in particular. And, according to the World Bank, the latest pandemic "has raised threats to India's economic outlook." The coronaviral pandemic in India can be "the largest crisis since Independence," Raghuram Rajan, former Chief of the Reserve Bank of India said.

In India, up to 53 percent of businesses ensured a certain effect of COVID-19 shutdowns on operations as per the March study from the FICCI (Federation of Indian Chambers of Trade and Industry). The 'Center for Indian Economy Monitoring' says that the unemployment rate rose by almost 19% in India by 24 April in a month's time to 26%. Some 140,000,000 Indians (14 crores), when they locked up, lost their jobs. Unlike last year, over 45% of households across the country reported a decrease in revenue^[1].

Since 2018-19 Indian economic growth decreased 8% in FY18 Q4 to 4.5% in FY20Q2, India experienced a pre-pandemic slowdown, even before the pandemic^[1]. The International Monetary Fund itself reduced the Indian GDP projections for the year 2019 and even reduced the GDP forecast for 2020 well before the India pandemic lockdown or reactions. The 2016 demonization of Indian banknotes and the tax implementation on goods and services in 2017 culminated in significant reverse economic upheavals. There have been many banking problems, like the infrastructure leasing and financial services crisis, as well as policy failures like 'Make in India' occurred. In the year preceding the lockdown there was a major 'wage squeeze' for both the rural and urban sector.

1. Impact of Covid-19 lockdown on economic status of various national sectors

Many industries including hotels and airlines are slashing pay and laying off jobs. Transport firms like Ola Cabs decreased their sales by nearly 95% in March and April leading to 1400 redundancies. The loss for the tourism industry has been projected to be €15,000 crore for March and April alone (US\$ 2.1 billion)^[11].

The Indian Industry Confederation (CII), the Associated Commerce and Industry Chambers of India, and FAITH claim the vast majority of tourism workers in India face unemployment. The Association is also a major player in the field of tourism. A total loss of about \$3000 crore (USD420 million) has been reported in the live event industry. A drop in funding is impacting many new start-ups. A DataLabs study reveals a 45% decline in total growth funding (Series A round) compared to the fourth quarter of 2019. The venture capital report of the Indian startups decreased over 50% in Q1, 2020 from the fourth quarter of 2019, according to KPMG (Klynveld Peat Marwick Goerdeler). Government revenue has been badly affected by the fall in tax collection and the government has sought ways to reduce its own costs. On 10th May 2020, Nitin Gadkari, Minister of the Union, said that in future some countries will not have enough resources to pay salaries.

The Indian economy is expected to lose over \$32,000 (US \$4,5 bn) to over \$32000 (US \$4,5 billion) according to Acuité Ratings [a joint initiative of SIDBI], which is registered as credit rating agency by the SMEs, Dun & Bradstreet Information Services India Private Limited (D&B) and leading public and private sector banks in India According to Barclays, for the first 21 days of closure, as well as the previous two days, cost approximately \$8.5 lakh crores (\$120 billion), the British multinational investment bank and financial services firm, based in London, England.

The Indian Industry Confederation (CII) has introduced a fiscal stimulus package amounting to 1% of India's GDP for a total of 2 lakh crore (US \$28 billion). The fiscal package and the monetary policy strategy are comparable in other countries like Germany, Brazil, and Japan. The Jefferies Group reported that the government is expected to spend 1.3 lakh crore (US\$ 18 billion) to counter coronavirus. Bloomberg economists believe that at least \$2.15 Lakh crore (\$30 billion) should be invested. Arvind Subramanian, former CEA, said Indian needs a US\$ 10 billion (US\$ 140 billion) opportunity to solve the contraction.

A) Energy

Night light radiance decreased in Delhi 37.2% from 1 to 31 March 2019, Bangalore dropped by 32% and Mumbai declined by 29%. In April 2020, Indian fuel demand dropped by almost 46% compared to last year. Cooking gas (LPG) sales have risen by 12%. India 's annual fuel consumption is projected to fall by 5.6% by 2020 in the April report of the International Energy Agency. The demand for diesel oil will decline by 6%^[11]. Since the COVID-19 pandemic, oil prices fell sharply in 2020 , demand has declined dramatically, too.

B) Agriculture

Throughout the subsequent lock-down month, 10% of farmers were not in a position to harvest their crop, and 60% of those who harvested reported losses of returns and the majority of farmers face difficulties for the following season. As logistical problems that emerged from lockdown, tea estates were unable to reap the first flush. As a result, tea exportations could fall by up to 8% annually. Tea exportation in March 2020 declined 33% from March 2019 in India^[11]. Food waste increased during the lockdown due to disrupted supply chains impacting small farmers.

C) Manufacturing

Larsen and Toubro, Bharat Forge, UltraTech Cement, Grasim Industries, the design and retail arm of the Aditya Birla Group, Tata Motors and Thermax have temporarily or substantially suspended or reduced their operations in various factories and mills across India. iPhone companies in India have stopped the bulk of their activities. With the exception of vital manufacturing plants, Hindustan Unilever, ITC, and Dabur India shutdown until further notice, far from all the two and four-wheeler firms. Foxconn and Wistron Corp, producers of iPhones, halted their production after 21 days of lock down orders.

D) Stock markets

SENSEX plummeted by 4000 points (13.15%) and NSE NIFTY decreased by 1.150 points (12.98%)^[11]. The financial markets of India announced worse losses on March 23, 2020. On 25 March, after a full 21-day lock-off was announced by the Prime Minister, SENSEX posted the highest profit in eleven years, adding value in total to 4.7 lakh crore (\$66 billion).

E) E-commerce

Amazon revealed in the third week of March that they are halting sales of non-essential goods in India in order to meet critical needs. In Italy and France, Amazon adopted the same approach. On 25 March, Walmart-owned Flipkart temporarily discontinued some of its e-commerce services and sold and distributed only essential goods. In addition, BigBasket and Grofers ran a limited service due to lockout disturbances. Delhi Police have started issuing passes to supplier agencies to facilitate their opening up of the supply chain.

F) Defence

The Military Affairs Department headed by the Chief of State Security deferred all acquisitions of resources to a decline in the coronavirus pandemic. There will be no new major defense agreements in the beginning of 2020–21 FY. While S-400 missile system delivery will not be affected, Rafale fighter jets could not be delivered. Yet France announced on 24 March that the delivery of the 36 Rafale jets was not postponed.

G) State income and expenditure

In contrast with 2019, the Delhi government is down 90% in terms of tax collection. The government aims to borrow and increase taxes in some sectors. Maharashtra has been putting all new investments on hold until next March, the government development budget for the current fiscal year was reduced by 67%. In April, the income of the government of Madhya Pradesh dropped 85%, though credit rates increased. Both the government of Delhi and the government of Andhra Pradesh have levied a 70% to 75% "corona" extra liquor tax. The liquor excision duty is the third largest source of revenue for many states, with some states almost

10-15% of the overall tax collection. The prohibition impacted alcohol consumption during the lockdown, which in effect had a major impact on the State's revenue.

H) Migrant workers and labor force

Regular wage workers (urban poor and migrant workers) have been left without jobs due to the lockdown. Around the same time, the limits on lockdowns prevented bus and train movement. Going back to the villages ended up huge numbers of migrant workers. Shortly after a direction by a central government in late March, state governments set up 21,000 camps in which more than 660,000 migrants could stay and end their exodus. By the last week of March, the Delhi Government had built more than 500 hunger relief centers. On 5 April, the government and non-governmental organizations' food camps provided food for 75 lakhs throughout the country. 37,978 relief camps and 26,225 food camps were built by 12 April. Health necessary items like masks, sanitizers and medicines were given to migrants at these camps in Kerala. Shortly after the nation-wide lockdown in March, Finance Minister Sitharaman revealed that the strategy for the poor will be to invest 1.7 lakh crore (US\$ 24 billion). This included cash transfers and food safety measures. The average daily salaries under the MGNREGA were increased from earlier on to ₹182 (US\$ 2.60) to ₹202 (US\$ 2.80), as of 1 April, to help the employees provide their jobs and wages^[1]. FM Sitharaman declared on 14 May that migrants would be given free food grains, targeting eighty million migrants by investing ₹35 billion (US\$ 490 million). The railways transported 48,00,000 immigrants back home on the special trains allocated from 1 to 27 May. While this service had initially not been free with additional charges over ordinary fares, the central government subsequently granted the railways 85% for train fares, while state governments supposedly financed the remaining 15%. A total of 91 lakh migrants concurrently traveled by train and bus. In order to attract factories and investments the governments of Uttar Pradesh, Madhya Pradesh and Gujarat attempted to amend their job law briefly in the beginning of May. Labor trade unions have resisted this as detrimental to workers, allowing more power for employers. Garib Kalyan Rojgar Abhiyaan was launched by the government in order to protect migrants on 20 June 2020.

Impact of Covid-19 on Animals

Lockdown measures that stopped people from leaving and shutting down shops and other businesses have seen animals travel free where they would not otherwise go. The fishing is also diminishing due to insufficient human activity, even marine turtles return to areas that have historically been avoided by them for laying their eggs. The lockdown has seen impact on decline in fishing, which means fish abundance may grow which almost depleted after overfishing. Animals who usually stay away from urban areas now have space for roaming as people self insulate in their homes. In northern India during the national shutdown of COVID-19, a herd of deer was found wandering along Haridwar streets. Also in the middle of Barcelona, Spain, wild boar have been spotted.

1. Impact of Covid-19 on global wildlife trade

A market selling wild animals in China, which focuses on the global trade in wild animals, was supposed to have caused the pandemic. In the aftermath of a first outbreak in Wuhan China placed a ban on all cultivation and sale of live animals that was supposed to become law at the end of this year. The Wildlife Conservation Society of New York calls on governments to prohibit livestock markets and discourage illicit wildlife trade and wildlife trafficking.



Figure 7: Covid-19 on Wildlife stock and trafficking

2. Impact of Covid-19 on the Global Animal Husbandry Market

The effect of coronavirus has been a major influence on the global animal husbandry sector. The demand for chicken and meat has fallen dramatically since the outbreak, because rumors were that the virus can spread by animal meat and chicken among the people. Prior to the pandemic, the key reasons behind the sector 's development were the increased consumption of

pork, beef, chicken and other marine items like crevices. Changing people's habits and their tastes for luxurious food were also the key drivers of market expansion.

The Animal husbandry industries are divided into milk , meat, poultry, aquaculture, and other (insects) by type. The COVID-19 pandemic is anticipated to significantly affect meat and poultry. Based on the global viewpoint, the USA, China, Italy, France, Germany, Spain, the United Kingdom and India are the most affected regions. As the virus spreads increased, the regional demand for chicken and meat declines. Moreover, people have also been shown to choose jackfruit as a substitute for chicken and mutton. Whereas, market growth has been affected by shutdowns in the food chains including restaurants.

3. Impact of Covid-19 on companion animals

The COVID-19 SARS-CoV-2 coronavirus is capable of detecting cells in many species, including cats and dogs, through interactivity with the cell surface protein ACE2. Coronavirus can infect our pets in some media reports.

Several domestic cats have also been successfully screened for their first US outbreaks of accompanied animals, with other endangered species such as tigers and lions also being checked in a positive way, according to the Centers for Disease Control and Prevention. Although the cat confirmed the disease positively in Belgium on 24 March.^[18]

Coronavirus has been found in many mammalian and bird animals, such as dogs and cats, and cattle such as goats, hens and pigs, and is not particularly friendly for potential hosts.

In Hong Kong, a 17 year old dog repeatedly screened the coronavirus as "weakly positive," but later died. A research published in Nature journal on 14 May investigated two COVID-19 incidents of dogs- the earlier mentioned 17-year-old Pomeranian dog and a 2.5-year-old German shepherd in Hong Kong^[18].

4. Impact of Covid-19 on zoo animals

Zoos around the world have been closed down as part of national locks-downs, and zoo owners say that the attention of humans is missing for their most intelligent and social animals – like gorillas, otters and meerkats. On the other side, some zoos are using their privacy as a whole. In Hong Kong's Ocean Park one of the resident pandas is believed to be pregnant after 10 years of natural matching.

5. Impact of Covid-19 on Ganges Dolphins

Dolphins found in the vicinity of Kolkata Ghats. After 30 years in the Ganga River the South Asian River Dolphins, also called Ganges Dolphins, have been found because of reduced water pollution during lockdown.



Figure 8: Dolphins found after 30 years in Ganga River at Kolkata Ghats

6. Impact of Covid-19 on Birds

The number of flamingos increased in Mumbai. The Covid-19 lockdown resulted in the collection in Navi Mumbai of tens of thousands of flamingos. The birds usually migrate to the area every year, although the population recorded a significant increase this year.



Figure 9: Increased Flamingoes in Mumbai after Covid-19 lockdown

Conclusion

Covid-19 is a global pandemic caused by SARS-CoV-2 which originated from China in December 2019. It affected human health severely. On 5 July 2020, the total number of cases were 673,165 with 409,082 recoveries and 19,268 deaths in the country. With the increase in the number of cases, demand for medical equipment and burden on doctors and healthcare professionals also increased. To stop the spread, the government imposed a lockdown which halted all human activities including industrial transporting and economical activities. All of these led to economic decline. Other than human suffering and psychological stress with economic loss as a negative impact, lockdown has positive side as well in reduction of pollution and healing of motherland- “The Earth”. Air quality improved with reduction of NO₂ and PM concentration. Study shows the result that at the airport clean air has been observed, as a result of no aircraft being used during lockdown. Car’s and aircraft’s fossil fuel is responsible for NO₂ emission which causes air pollution. Also, water quality has improved because of no industrial and human activities over the ghats of Ganga which made its water to drink. Not only nature bloomed during the lockdown, animals too recorded their happy time by enjoying without any human disruptions all over the places where they never dared to go.

How people will see world after the Covid-19 - “The New Normal”

Even after the lockdown is over, people will not see life as they were living before. There will be a new way of living for people with changed mindset. It will take longer to vanish their fear of getting infection (even when the vaccine will be available) and living life with new norms. There will be different methods to overcome and resolve the economical as well as other relatively issues. As during lockdown, people understand that they can enjoy life with 3-4 pairs of jeans and tshirts, there is no need to fill the wardrobe with numerous clothes so this will lead to lowering of consumption on unnecessary needs whereas the money can be invested on essentials. There will be more approaches for home schooling which means education can be done online from home and children can go to schools sometimes for group activities. Institutes and universities will also innovate with online approaches. Industries will show more interest in work from home(WFH) policies in which for offices it will reduce rent and for

employees it will reduce the travelling time. And with less use of vehicles will help to reduce air pollution. While working from home people will spend more time with families and loved ones. Also WFH will benefit rural India where people from villages will get a chance to be involved in some industries in those local areas as people from local areas will be hired not from other places or cities and of course these talents will be of lesser cost as compared to hiring people from cities. Another side of WFH will lead to commercial real estate collapsing because they will feel more pressure as people will work from a digital platform so there will be less requirements for offices which will lead to more burden on the commercial as well as residential real estate market. Digital transformation will accelerate in other sectors such as online shopping demand and deliveries will grow in the upcoming future. Coming to the medical front, there will be health checks besides security checks. It means in addition to security checking at airports, malls and hotels there will be a temperature check and need for a certificate of vaccination of covid-19. Television will be a much desired option for sports lovers because only players will be at the playground so there will be no audience to watch live sports, they will watch it remotely. Only important long distance business travel and must-travel situations will be considered and leisure travel will not be entertained anymore or they will be allowed to local places or geographical areas. Government will become e-government like AADHAR card and PAN card that have a unique identity for everyone, other services of government will also be online. While people are at home, machines in the manufacturing sector can run the supply chain.

Suggestions for accepting and applying the new normal

1. With the increasing severity, people are advised to take preventive measures for covid-19. Most things became a part of routine life. Other safety measures should be adopted in their normal daily life as new habits which we call it as new normal in one's personal life.
2. Wearing a mask should be mandatory while stepping out from home. People should bath just after coming home from anywhere and should put their clothes to wash.
3. People have to wash their hands frequently to maintain proper hygiene. Using sanitizer frequently to reduce risk of infection can help to prevent suffering from disease and

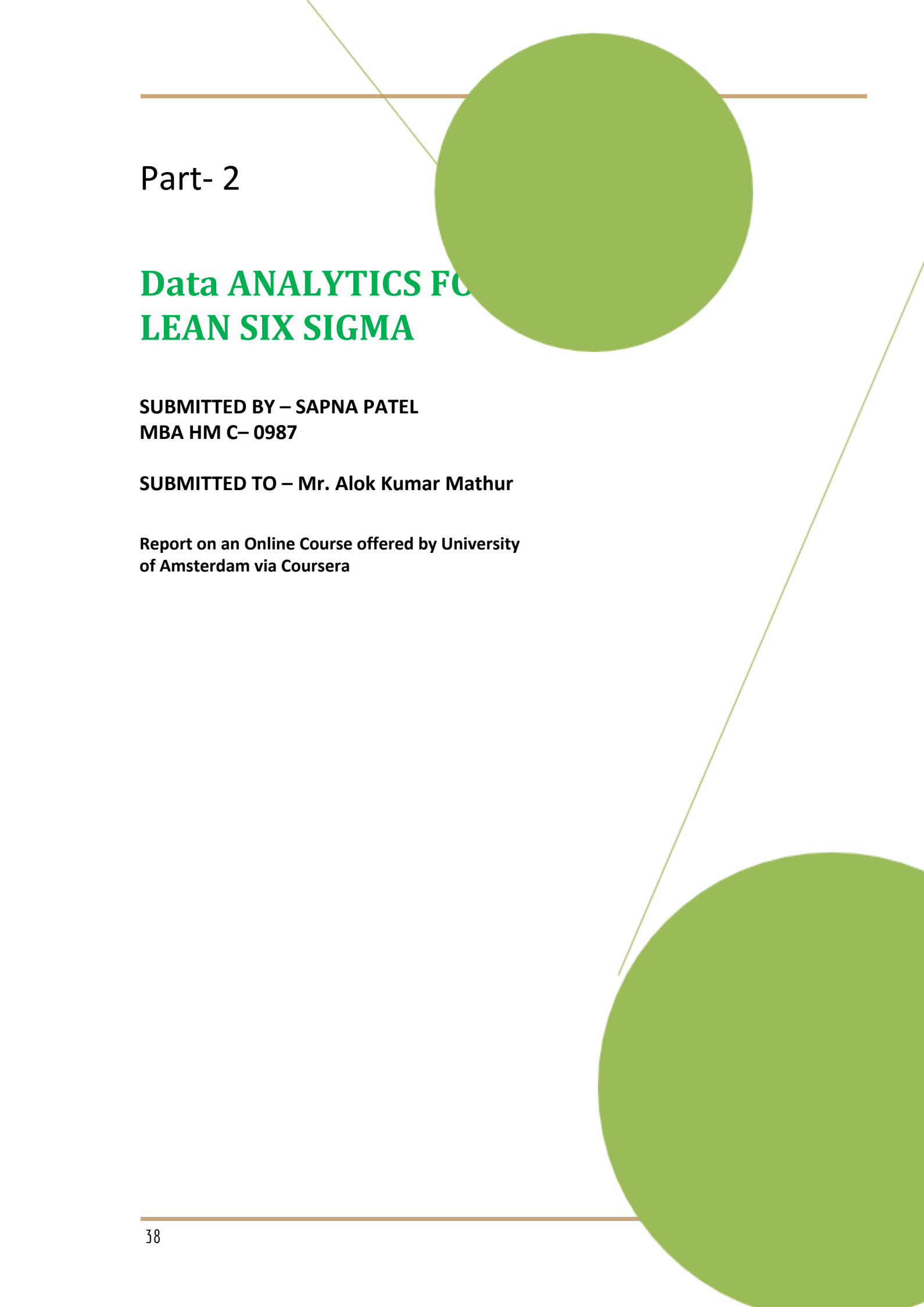
also helpful to prevent family members specially eldest people from spreading of infection.

4. Maintaining social distance at every place is one of the ways to prevent infection until a vaccine is available.
5. While keeping safe ourselves, we also have to analyse causes of pandemic and lifestyle we were living from the pandemic, during the pandemic and the life after the pandemic. For the future, people have to adjust with new norms in every sector.
6. People should learn and adopt new ways of living like working from home where there will be less use of vehicles which will emit lower amounts of harmful pollutants that will reduce air pollution. Use of electrical vehicles is another good option in reduction of air pollution. While working from home people can also spend their time with families and loved ones.
7. Virtual communication and working remotely using digital platforms is a new innovation that people should accept and apply.
8. Also, people should be more responsible as industrial wastage should be dumped in rivers within norms and water usage from the rivers should be with rules and regulations.
9. This should be learned from pandemic that nature is a beautiful gift of God and humans should understand the importance of our environment deeply and should take preventive measures to reduce pollution so that earth will heal even after the hurt it will receive from the people.
10. And if this type of condition will arise again then it will be bad for human life because death and suffering are the most painful impact on humans. Also with disturbances in their living sources like economic fall, cost for treating such pandemics while imposing lockdown are negative on humans. But it will be good for environmental conditions with less human activities. This will also be good for animal life.
11. And to fight such kinds of conditions in future, we must prepare ourselves with improved medical facilities and we must have increasingly talented doctors, health professionals and researchers.

Reference

1. <https://www.indiatoday.in/education-today/gk-current-affairs/story/covid-19-4-vital-environmental-changes-evidenced-in-india-since-lockdown-1673726-2020-05-02>
2. <https://www.nasa.gov/feature/nasa-probes-environment-covid-19-impacts-possible-links>
3. <https://www.thehindubusinessline.com/opinion/columns/the-effect-of-covid-19-on-indias-air-quality/article31564038.ece>
4. <https://www.investindia.gov.in/team-india-blogs/how-covid-19-impacting-environment-around-us>
5. <https://economictimes.indiatimes.com/magazines/panache/nasa-to-study-impact-of-covid-19-on-environment-using-satellite-imagery-hopes-to-map-user-behaviour-during-pandemic/articleshow/75756440.cms>
6. <https://www.sciencedirect.com/science/article/pii/S0048969720326036>
7. <https://www.downtoearth.org.in/blog/covid-19-lockdown-a-ventilator-for-rivers-70771>
8. <https://www.hindustantimes.com/india-news/economic-impact-of-covid-19-pandemic-to-vary-in-sectors/story-DIWjwnBZoON7ZUvgSMSFOL.html>
9. <https://www.statista.com/topics/6304/covid-19-economic-impact-on-india/>
10. <https://indianexpress.com/article/explained/explained-how-has-covid-19-affected-the-global-economy-6410494/>
11. https://en.wikipedia.org/wiki/Economic_impact_of_the_COVID-19_pandemic_in_India
12. <https://www.weforum.org/agenda/2020/03/this-is-the-human-impact-of-covid-19-and-how-business-can-help/>
13. <https://www.timesnownews.com/health/article/covid-19-impact-on-human-body-researchers-find-how-coronavirus-affects-lungs-differently-from-the-flu/597580>
14. https://www.researchandmarkets.com/reports/5013478/impact-of-covid-19-on-the-global-animal-husbandry?utm_source=dynamic&utm_medium=BW&utm_code=pdmffg&utm_campaign=1381443+-+Impact+of+COVID-19+on+the+Global+Animal+Husbandry+Market%2c+2020&utm_exec=joca220bwd

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15. <https://www.moneycontrol.com/news/coronavirus/covid-19-india-can-turn-this-crisis-into-a-n-environmental-and-economic-opportunity-5158591.html>
 16. <https://www.india.com/festivals-events/world-environment-day-2020-positive-impact-of-covid-19-lockdown-on-environment-4047703/>
 17. <https://news.yahoo.com/impact-covid-19-global-animal-150500991.html>
 18. <https://www.cnet.com/how-to/coronavirus-in-cats-and-dogs-how-does-covid-19-impact-pets/>
 19. <https://www.weforum.org/agenda/2020/04/coronavirus-animals-wildlife-biodiversity-tiger-boar-pandas-zoos/>
 20. <https://www.thehindu.com/sci-tech/energy-and-environment/covid-19-lockdown-like-interventions-may-help-combat-air-pollution-in-india-say-scientists/article31746151.ece>
 21. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7147210/>
 22. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_India
 23. <https://economictimes.indiatimes.com/industry/healthcare/biotech/healthcare/demand-for-sanitizers-masks-at-a-fever-pitch/articleshow/74127545.cms>
 24. <https://www.financialexpress.com/brandwagon/what-will-be-the-new-normal-post-covid-19/1961789/>



Part- 2

Data ANALYTICS FOR LEAN SIX SIGMA

**SUBMITTED BY – SAPNA PATEL
MBA HM C– 0987**

SUBMITTED TO – Mr. Alok Kumar Mathur

**Report on an Online Course offered by University
of Amsterdam via Coursera**

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COURSE DESCRIPTION

The course focuses on data management strategies that are usually useful for development programs under Lean Six Sigma. This discusses how data collected in such a project can be processed and interpreted. MINITAB is based on the use of statistical tools. It focuses on the use of tools for data analysis and the interpretation of results. Many examples of existing Lean Six Sigma projects are discussed to highlight all methods.

A Lean Six Sigma improvement project is the setting selected for the example. However, methods for data analytics are commonly used.

The Lean Six Sigma approach combined with the use of data analytics will improve operational efficiency and foster innovation. Applying the framework for defining, measuring, analyzing, improving and monitoring (DMAIC) any business process or objective process. It aims to decrease and eradicate waste, minimize product or system defects and enhance satisfaction of our customers.

OBJECTIVES OF THE COURSE–

The basic aim of the Lean Six Sigma approach is to incorporate a measurement technique to strengthen processes and reduce variability. Lean Six Sigma is aimed at improving performance by defining and removing the cause of errors and by using a range of quality control and statistical instruments to reduce variability ..

COURSE CONTENT

Data Analytics for Lean Six Sigma – University of Amsterdam

Module 1 – Data and Lean Six Sigma

- Lean Six Sigma
- DMAIC framework
- Minitab

Module 2 – Understanding and visualizing data

- How to visualize data
- Visualizing single as well as two variables
- Pareto Analysis

Module 3 – Using probability distributions

- How to quantify uncertainty
- Probability Plot

Module 4 – Introduction to Testing

- Model CTQ and Influence factors
- Decision tree to select appropriate tool for data based testing
- Causality

Module 5 – Testing Numerical Y and Categorical X

- How to establish relationship between a numerical Y variable (CTQ) and Categorical influence factors (X variable)

Module 6 – Testing Numerical Y and Numerical X

- How to establish relationship between a numerical Y variable (CTQ) and numerical influence factors (X variable)

Module 7 – Testing: Categorical Y

- How to establish relationship between X & Y whenever Y variable is categorical

LEARNING METHODOLOGY –

Videos and quizzes from coursera

KEY LEARNINGS -

WHAT IS A PROCESS?

Processes are a series of actions or steps taken to make a product or deliver a service. Processes take place everywhere. E.g. - Encapsulation Process of Medicine

A very popular way to improve processes is **Lean Six Sigma**. It is a stepwise method for running a Process improvement project.

Data is improvement in process improvement to:

- Find biggest problems
- Diagnose current process
- Investigate effect of improvements

DATA & DMAIC

Lean Six Sigma offers a roadmap known as DMAIC. These five phases prescribe a step wise procedure for process improvement based on measurements and evidence based improvement actions.

Define	Select project and establish objectives
Measure	Make the problem quantifiable and measurable
Analyze	Analyze the current situation and make a diagnosis
Improve	Develop and implement improvement actions
Control	Control the improved process performance and close the project.

CTQ

A CTQ (critical to quantity) is a property of a product, product or a service that is relevant to the project objective. CTQ in Lean Six Sigma terminology also known as Y variable or Dependent variable or the outcome variable.

UNITS: The ‘People, objects or phenomena’ you collect data on. A unit is called the experimental or observational unit or sometimes referred to as a case.

MEASUREMENT UNITS: What a measurement means

There is never one correct operational definition. One should look for the most sensible definition.

WHY SAMPLING?

- It is difficult to obtain information on the whole population.

A sample should be representative. The study must therefore be based on a method which is irrelevant to the query you want to answer.

A random sample has some advantages

- It ensures selected units are spread evenly over the population.
- It will spread out the selected units evenly over the moment of the date.

A Dataset consists of

- Units : People, objects or phenomena
- Variables: Properties that are measured

Organize your dataset as:

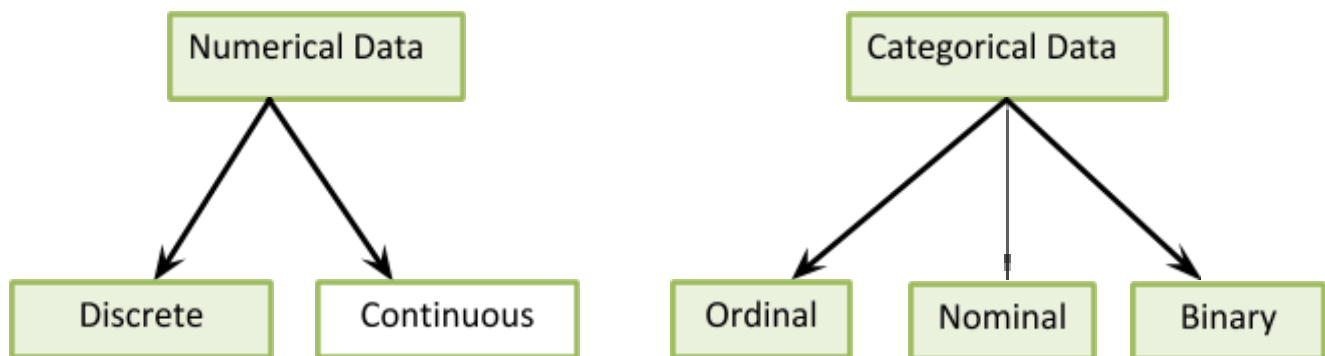
- Units in the rows
- Variables in the columns

MINITAB

This is a software application for statistics. This is used by belts carrying out Lean Six Sigma programs in many companies. It provides an effective means for the statistical data to be entered, manipulated, trends and patterns established and responses to current issues

extrapolated. This platform is the most frequently used by businesses of all dimensions – small, medium and large. For most Six Sigma ventures, Minitab offers an effective and quick solution for the analytical level needed.

NUMERICAL AND CATEGORICAL DATA



Numerical (quantitative) data:

Real-valued or whole numbers: 85.3 °C (temperature), 2.12 mm (dimension), 14 people (counts)

- *Discrete*: Variables that can only take integer values, such as counts (number of people, number of mistakes). Variables can also be discrete because of rounding.
- *Continuous*: Values not limited to integers, such as a distance or temperature.

Categorical (qualitative) data:

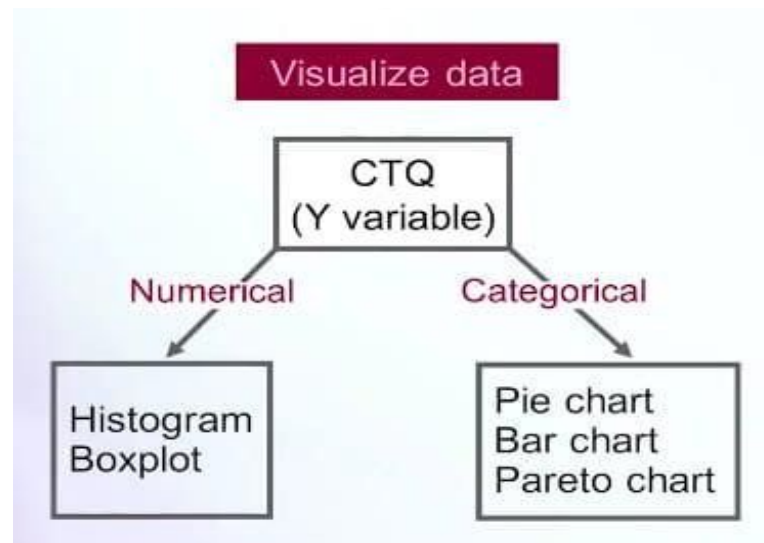
Subtraction and addition have no meaning

- *Ordinal data (order)*: there is a well-defined order among categories. Example: good, acceptable, critical, reject.
- *Nominal data (nomen = name)*: unordered categories; merely labels. Example: type XO, MM, SW, LS.
- *Binary data (bi = 2)*. Example: pass/fail, positive/negative, ok/nok.

Why make the distinctions between Numerical and Categorical data?

- **Information Density**. Numerical Data contains more information than categorical data. For Categorical data, more observations are required than numerical data.

- It determines which tool one should use. If Y variable is numerical, then one can make a histogram or a boxplot. However, if the variable is categorical. One can make a pie-chart, bar-chart, or a Pareto chart.



Descriptive Statistics: These are only available for Numerical data because they are based on Mathematical operations like addition and multiplication.

Example –

Variable	N	N *	Mean	SE Mean	StDev	Min	Q1	Median	Q3	Max
Caffeine %	40	0	0.08317	0.00259	0.01636	0.044	0.07225	0.0845	0.094	0.118

Where,

N – Number of Values/measurements

N* - Missing values

Mean – Location of the data

StDev – Dispersion of the data

Minimum – lowest value measured

Median – middle value: Location

Maximum – Highest value measured

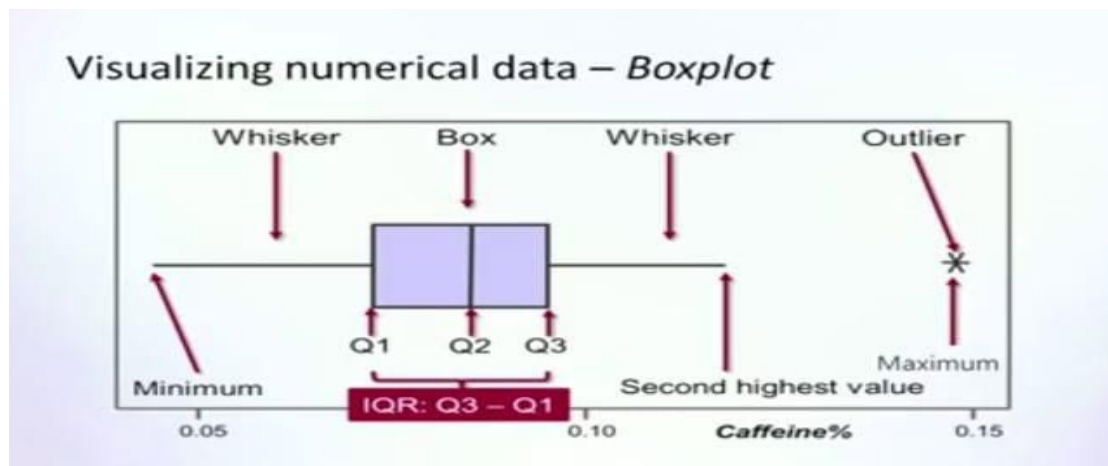
Q1 and Q3 – First and third quartile

Interquartile Range – Q3-Q1

Range – Maximum- Minimum

BOXPLOT –

- The median of the data
- The bulk of the data. Ranges from Q1 to Q3
- The Whiskers: indicate the tails of the distribution
- Possibly outliers

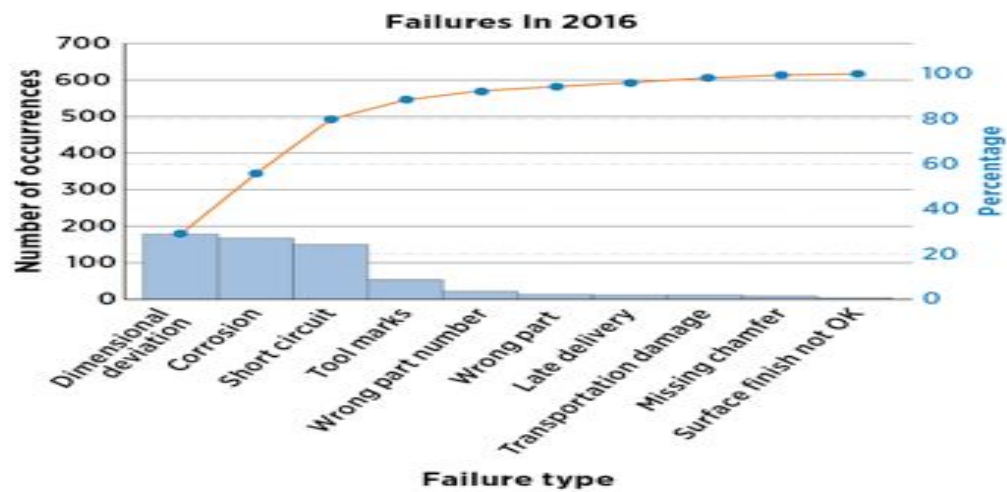


Techniques for Visualizing a Single variable

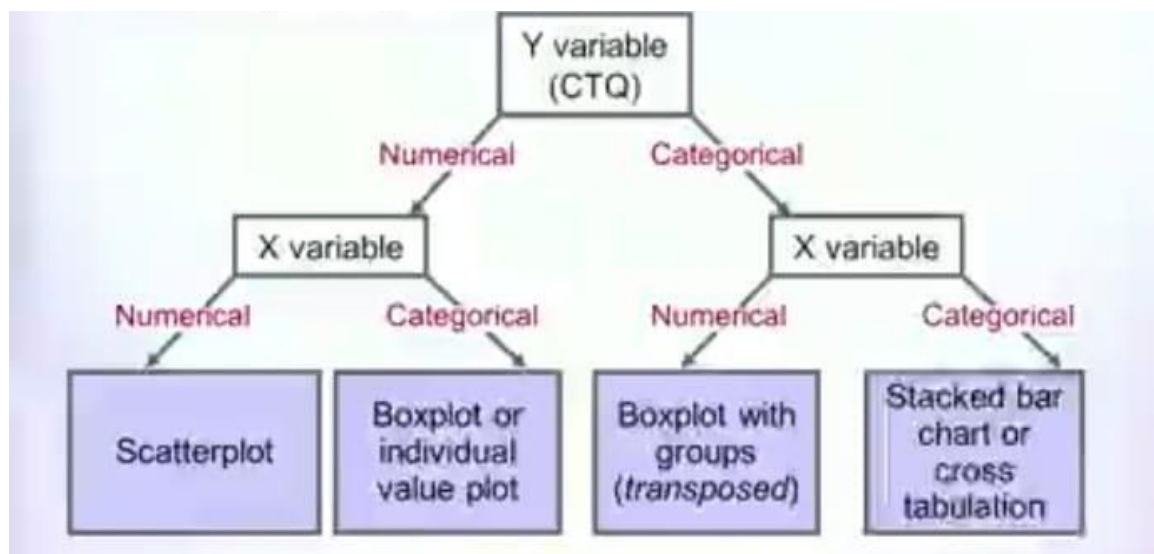
- Pie-Chart
- Bar-Chart
- Tally Table

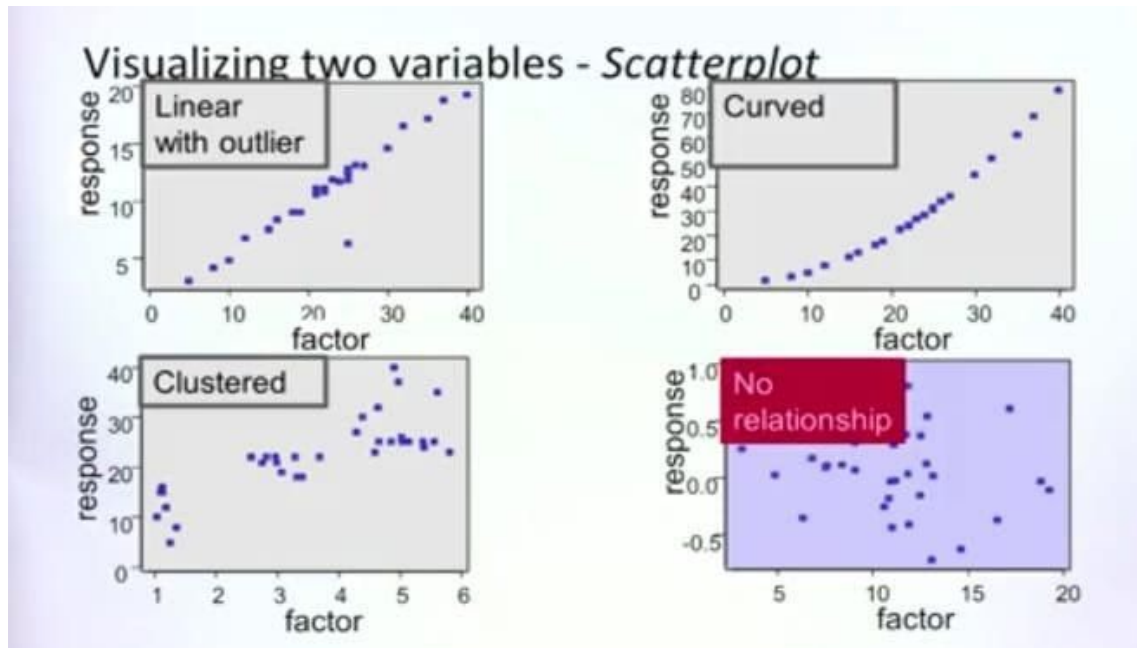
PARETO – ANALYSIS

80% of all problems can be attributed to 20% of the causes. The 80/20 principle, also known as the Pareto Principle. A Pareto chart can help you single out the few vital issues, from the trivial many. You can make the chart with frequencies to single out the problem that occurs most often. You can also make a chart with another variable, like duration, to find out which problems take up most of the time.



Visualizing Two Variables



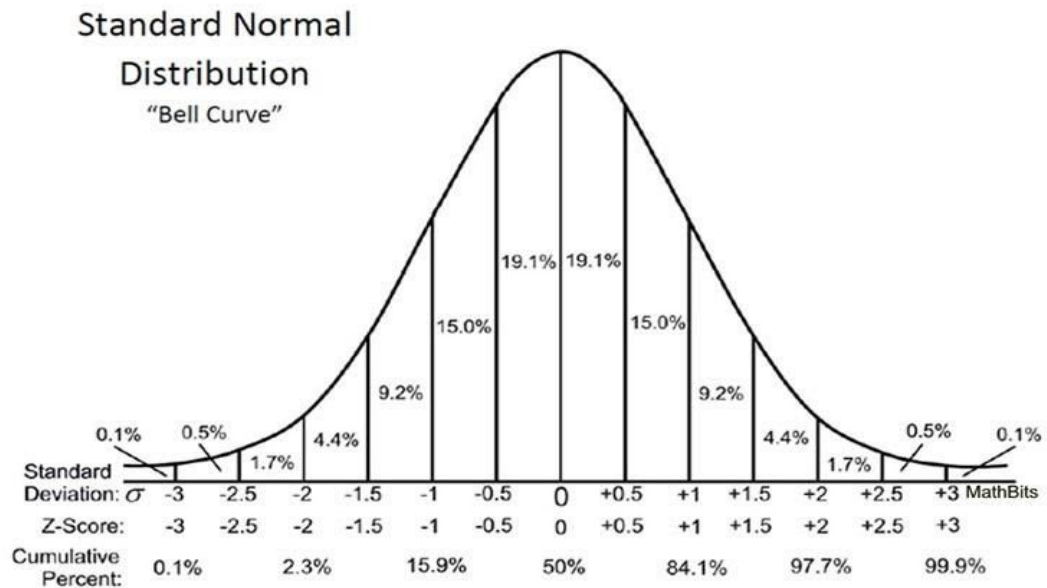


CONFIDENCE INTERVALS – Estimates appropriate unknown population parameters. We use confidence intervals to quantify this uncertainty. It gives you boundaries where the population mean will be in between, with a certain level of confidence.

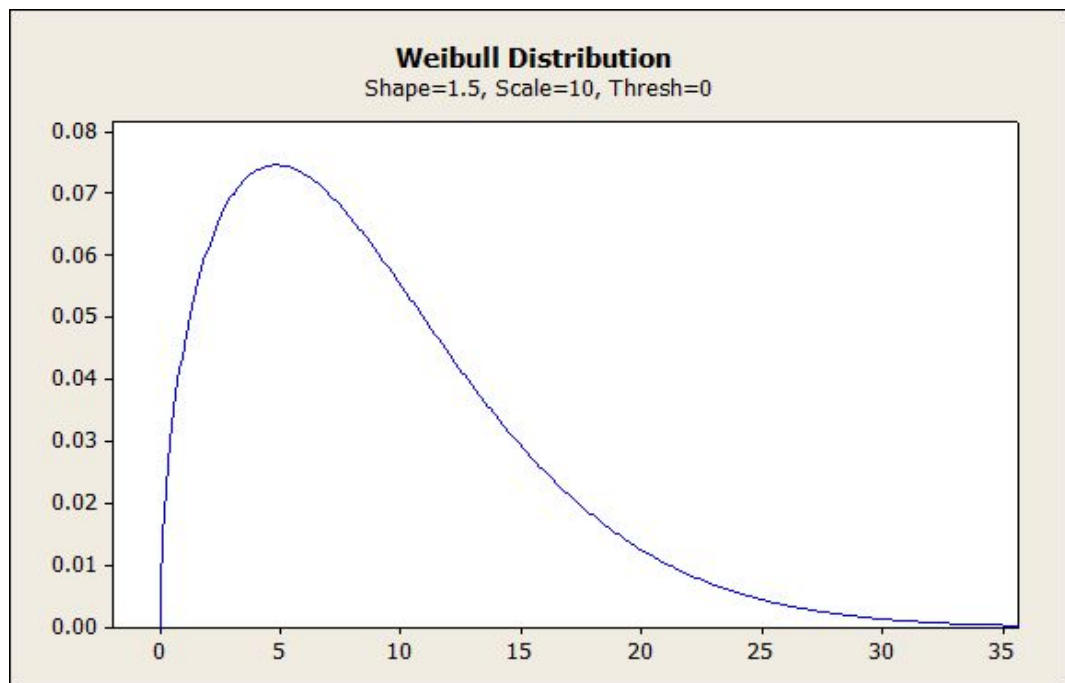
PROBABILITY DISTRIBUTION GRAPHS

3 Types of Probability Distribution Graphs

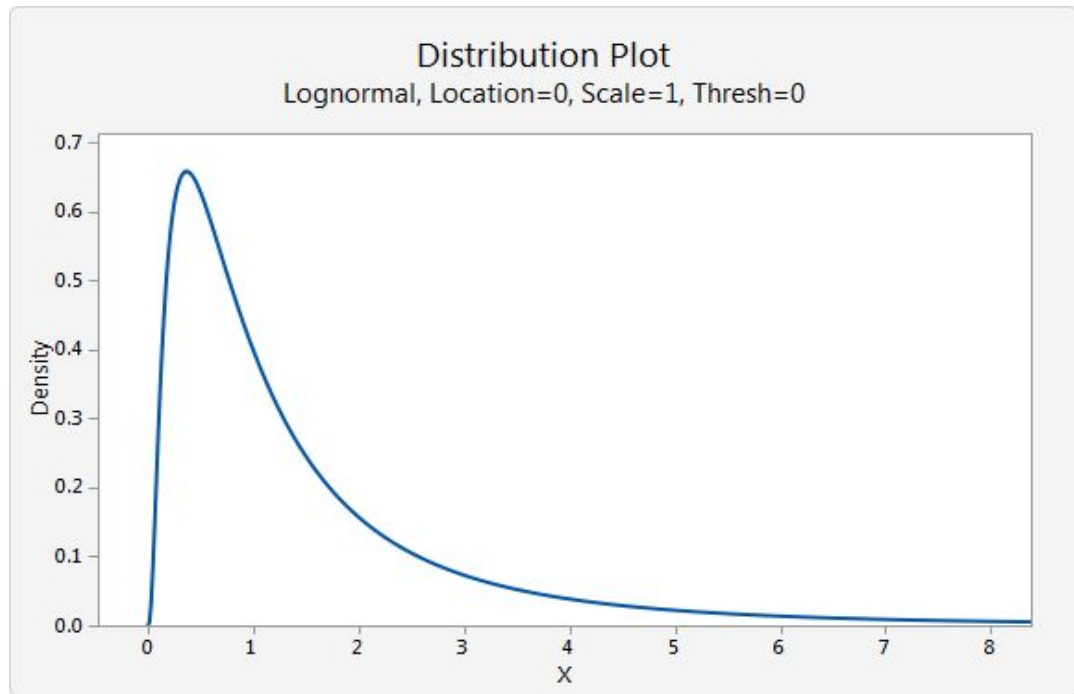
- **Normal distribution-** It is symmetrical around the mean. A bell shaped curve. Also known as Gauss curve.



- **Weibull distribution** – Also called skewed distribution. A distribution like this is called skewed to the right, because the tail is to the right. The Weibull distribution is often used for data, like, throughput times, and processing times, because these are often skewed variables.



- **Log- normal distribution** – A continuous probability distribution of a random variable whose logarithm is normally distributed. Also, referred to as Galton Distribution.



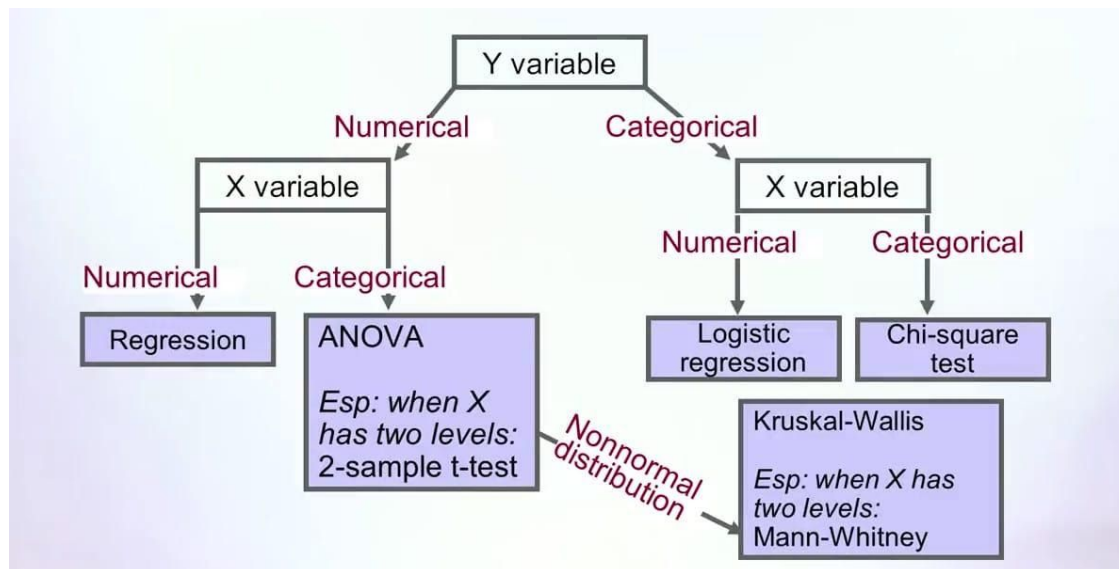
PROBABILITY PLOT – A visual tool used to fit a distribution to the data. It can be used to spot data anomalies. The probability plot clearly shows outliers. It can also help to detect bimodality. In that case, one will see an S shape representing the two distributions. Probability plots that have a small stack of data really show that the data have been rounded off.

Anderson Darling Values, it is the Anderson darling statistic. It measures the distance between 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.

Empirical CDF – It is used to determine the percentage of cases that meet SLA (service level agreement) or specifications.

DATA ANALYSIS

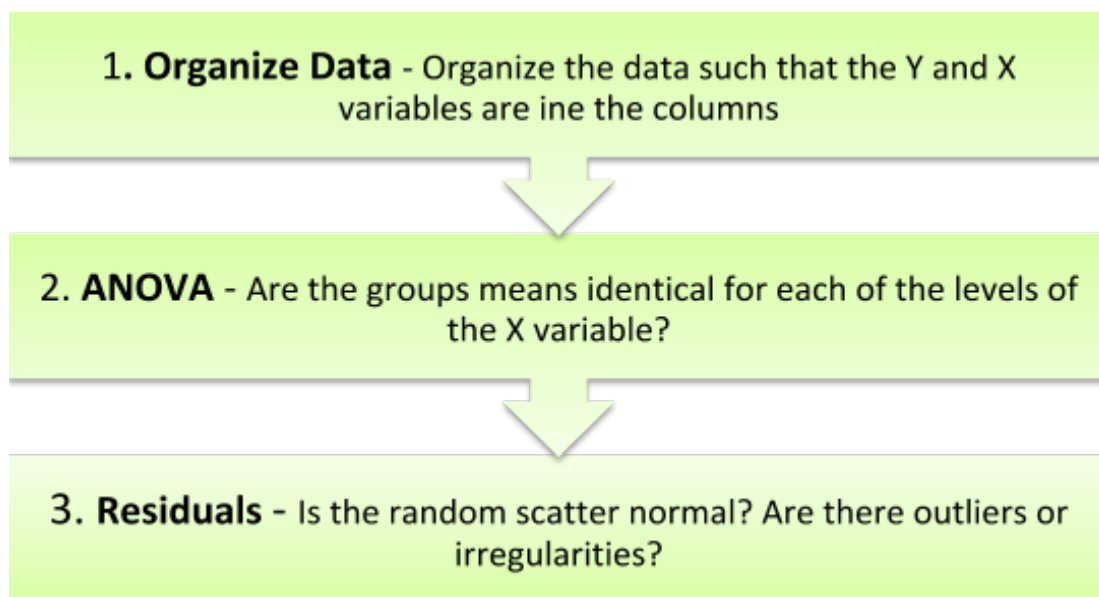
Data-based testing of ideas and improvements is one of the principles of Lean Six Sigma. This Principle is sometimes referred to as Evidence-based improvement actions. There are many methods to analyze data. These are ANOVA, Regression, Logistic regression and Chi-square test. These methods depend on the type of data one has. First, we have to determine the influence factor (X) and CTQ(Y). It depends if CTQ and Influence factor are categorical or numerical variables.



Hypothesis Testing – It is a procedure used to arrive at a decision as objectively as possible. It deals with uncertainty in a rational manner.

Testing: Numerical Y and Categorical X – ANOVA

ANOVA – It is the appropriate statistical technique when the Y variable is Numerical and X variable is Categorical. ANOVA is performed in 3 basic steps. These are:-



p-Value determines significance.

- Below 0.05; X has a significant effect

-
- 0.05 or higher; X is not significant

R^2 indicates importance/ relevance.

- Large R^2 : Important X
- Small R^2 : Trivial X

ANOVA Residuals – Residuals are calculated by subtracting the mean of the relevant machine from each observation. (Residual = Measurement – group mean)

KRUSKAL-WALLIS Test

A non-parametric test. This means that there is no specific distribution assumed on the residuals. ANOVA is based on assumptions that residuals are normally distributed, and that the residuals contain no irregularities such as outliers. The Kruskal-Wallis Test is less powerful than ANOVA as we let go of the assumptions.

Two- Sample t-test

Also known as the student's t-test. It is a method used 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. It is a very old test and forms the building block of many other tests that have been developed since.

TEST FOR EQUAL VARIANCES

Increasing variability always degrades the performance of the production system. This is the law of variability. Compare variances across groups with the test for equal variances. It can also be used for the ANOVA analysis to determine if the 'assume equal variances' mode can be used (p-value will be more precise).

Testing Numerical X and Numerical Y

Correlation: It 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.

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 correlations

0 to -0.4 – No or weak negative correlation

-0.4 to -0.8 – Moderate negative correlation

-0.8 to -1 – Strong negative correlation

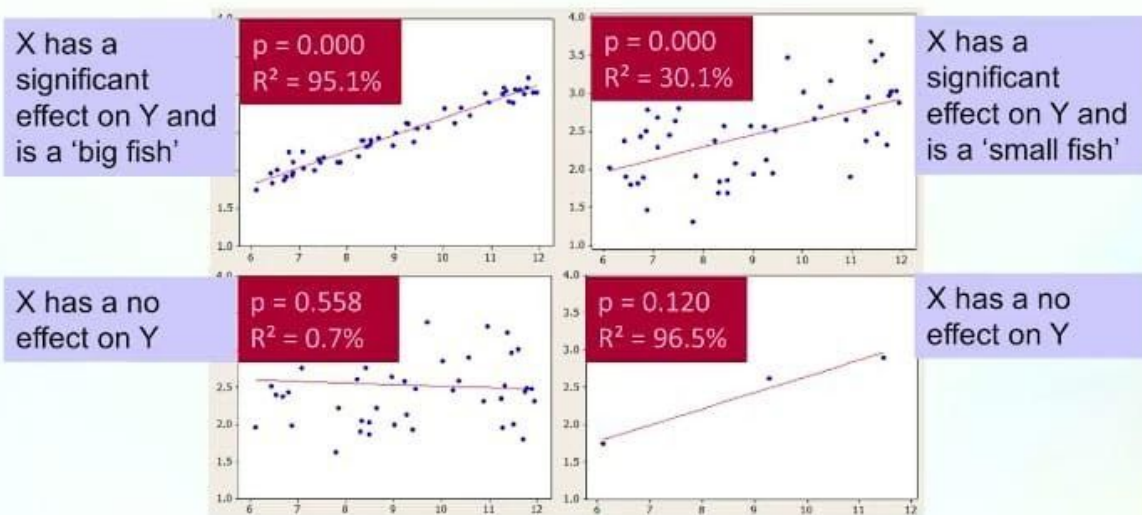
Regression: Regression analysis is about finding the best fitting linear line. A line can be described mathematically by the formula $y = a + bx$. Regression analysis means finding the a and b that gives the best fitting line. Regression analysis consists of four steps.

These are:-



- The fitted line plot indicates the constant (a) and the slope (b) of the line.
- The p -value indicates whether the findings are due to chance or real
- The R^2 indicates how strong the relationship is

Regression – p -value and R^2 – examples



Regression – Residual: Observed value (data) – fitted value (estimated regression line)

Possible Solutions

- Outliers - Remove outliers (always report this!)
- Non-Linearity – Quadratic regression
- Other problems – Many possible solutions

Quadratic Regression – If the assumptions of regressions are not met, you have to perform Quadratic regression. A quadratic regression fits a curved line.

Testing Categorical Y

Chi-square analysis – It is a suitable method if you have a categorical Y and a categorical X. The first step is to make a cross-tabulation. The second step is to look at the p -value and check if the results are significant.

Logistic Regression – It is used to study the relation between categorical Y and numerical X variables.

It is done in 3 steps:-

1. Enter data in event/trial format

-
2. Make fitted line plot
 3. P-value

Learnings From the Course:-

1. The Lean Six Sigma methodology focuses on reducing and eliminating waste, lowering defects in products or methods by using a set of quality management and statistical tools and improving customer satisfaction.
2. Lean Six sigma is a very popular way to improve processes. Processes are a series of actions or steps taken to make a product or deliver a service. Lean Six Sigma offers a roadmap known as DMAIC (Define, Measure, Analyze, Improve and Control) for process improvement.
3. A CTQ (critical to quantity) is a property of a product or a service that is relevant to the project objective. Also called as Y variable.
4. The People, objects or phenomena you collect data on are called units. A unit is called the experimental or observational unit or sometimes referred to as a case. It is difficult to obtain information on the whole population so the sampling is done. A sample has to be representative. Random sample ensures selected units are spread evenly over the population.
5. Collected data should be arranged in a way like Units in the rows and Variables in the columns.
6. Minitab is a statistical software package. It provides a simple, effective way to input the statistical data, manipulate that data, identify trends and patterns, and then extrapolate answers to the current issues.
7. Numerical Data Is Discrete and Continuous and Categorical data is Nominal Ordinal and Binary. Numerical data contains more information and categorical data contains more observations. If Y variable is numerical, then one can make a histogram or a boxplot. However, if the Y variable is categorical. One can make a pie-chart, bar-chart, or a Pareto chart.

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8. Confidence interval estimates appropriate unknown population parameters. We use confidence intervals to quantify this uncertainty. It gives you boundaries where the population mean will be in between, with a certain level of confidence.
 9. There are 3 types of Probability distribution graphs: Normal distribution(Gauss curve), Weibull distribution(skewed distribution), Log-normal distribution(Galton Distribution).
 10. Probability plot is a visual tool used to fit a distribution to the data. It can be used to spot data anomalies. The probability plot clearly shows outliers.
 11. Anderson darling values measure the distance between 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.
 12. Data-based testing of ideas and improvements is one of the principles of Lean Six Sigma. This Principle is sometimes referred to as Evidence-based improvement actions. There are many methods to analyze data. These are ANOVA, Regression, Logistic regression and Chi-square test.

THANK YOU