

**IMPLEMENTATION OF STATISTICAL  
PROCESS CONTROL IN  
METEOROLOGICAL DEPARTMENT **RAINFALL VALUES**  
BY  
USING MATLAB**

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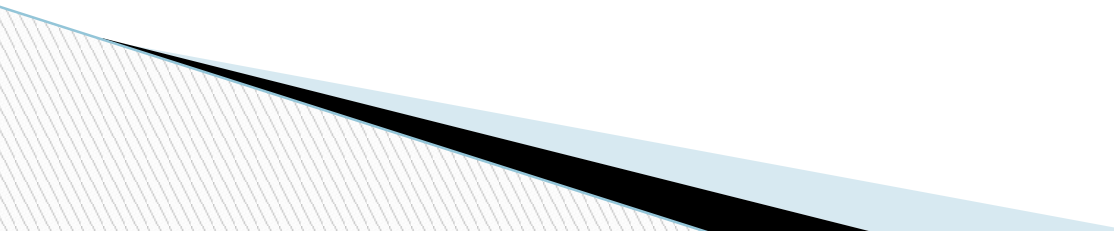
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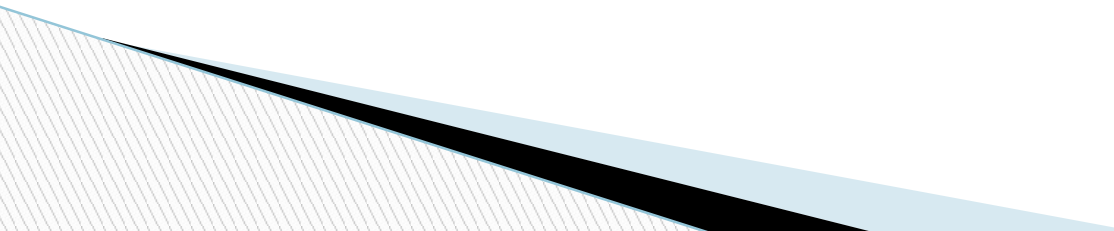
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# Objective

- There is a variance in representing the weather forecasting which is in the form of dynamic data so there will be some deviation occurs in the forecasting.
  - To represent the variance in the weather forecasting SPC is used so that we can represent it as a static data which is collected can be plotted and the error can be rectified using MATLAB model.
  - By implementing statistical process control (SPC) we can predict the weather reports.
  - It can reduces collateral damage caused by weather.
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# INTRODUCTION

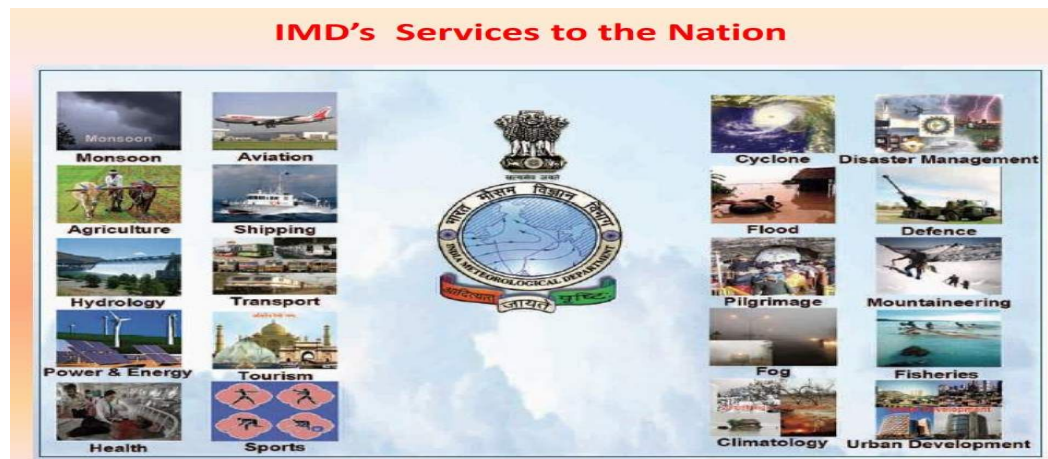
- ❑ Generally in the meteorological department the weather reports which are forecasted are not predicted properly.
- ❑ A forecast is the prediction of climatic events. So this paper focused on implement and monitoring the statistical process control.
- ❑ In the statistical process control the error and data samples can be regulated various errors and sample can be analyzed and model is frame.

**SOURCE:**<https://www.nakkheeran.in/24-by-7-news/thamizhagam/tamilnadu-rains-chennai-regional-meteorological-centre-0>



- ❑ The preparatory phases of SPC involve several different tools.
- ❑ For control charts the data are retrieved from IMDC which are fed to identify the weather measurement value in the region using MATLAB.
- ❑ Matlab provides tools that you need to acquire and automate tasks
- ❑ Once you acquire data, you can explore it and perform live visualisation and data analysis

**SOURCE:** <https://www.yumpu.com/en/document/view/35239654/imd-was-established-in-india-meteorological-department>



# Meteorological parameters

Standard meteorological parameters are

- i. Temperature and humidity
- ii. Wind speed and direction (speed, height)
- iii. Air density
- iv. precipitation
- v. pressure and barometric pressure

vi. Rainfall

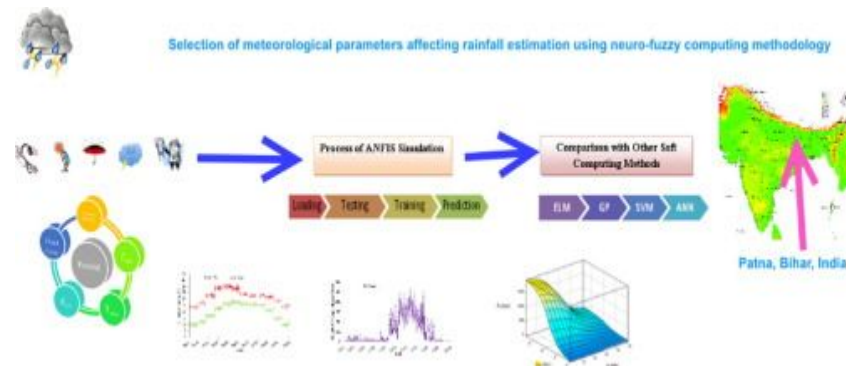
vii. Sunshine

viii. Evaporation

Flooding parameters:

One threat to public safety is flooding. It has own sets to parameters are

- i. Tide Prediction
- ii. Water level
- iii. Wave height



**SOURCE:**<https://www.sciencedirect.com/science/article/pii/S0169809515003920>

- Rain gauge is used to measure the rainfall - amount of liquid precipitation over a set period of time.
- The Rate of rainfall is similarly expressed in millimeter per hour

**SOURCE:**<https://www.thehindu.com/children/what-are-rain-gauges-how-are-they-used-to-measure-rain/article35758124.ece>



## Literature review

SL.N O	Authors Names	Title of the Journals & Journals publishes & Year	Inferences
1	Mamta Parmar,' Er.Harpreet singh oberoï, Er.Gaurav Kalia and Harpreet kaur	Diagnostic tools to revive sick manufacturing unit s using SPC (Statistical process control)  International journal for research and development in technology  2016	<ul style="list-style-type: none"> <li>•To determine Statistical Process Control with the help of control charts can give the significance improvement to the quality from the all above quality tools .</li> <li>•By using the quality tools and statistical techniques quality can be achieved.</li> </ul>



## Literature review

SL.N O	Authors Names	Title of the Journals & Journals publishes & Year	Inferences
2	Jafri mohd rohani, Chank kok teng	Improving quality with basic statistical process control tools  Jurnal teknologi  2001	<ul style="list-style-type: none"> <li>•It is used to improve the quality of plastic injection moulded lenses used in telecommunication devices.</li> <li>•The average defect has improved to 7.4 % from 13.49 %</li> </ul>

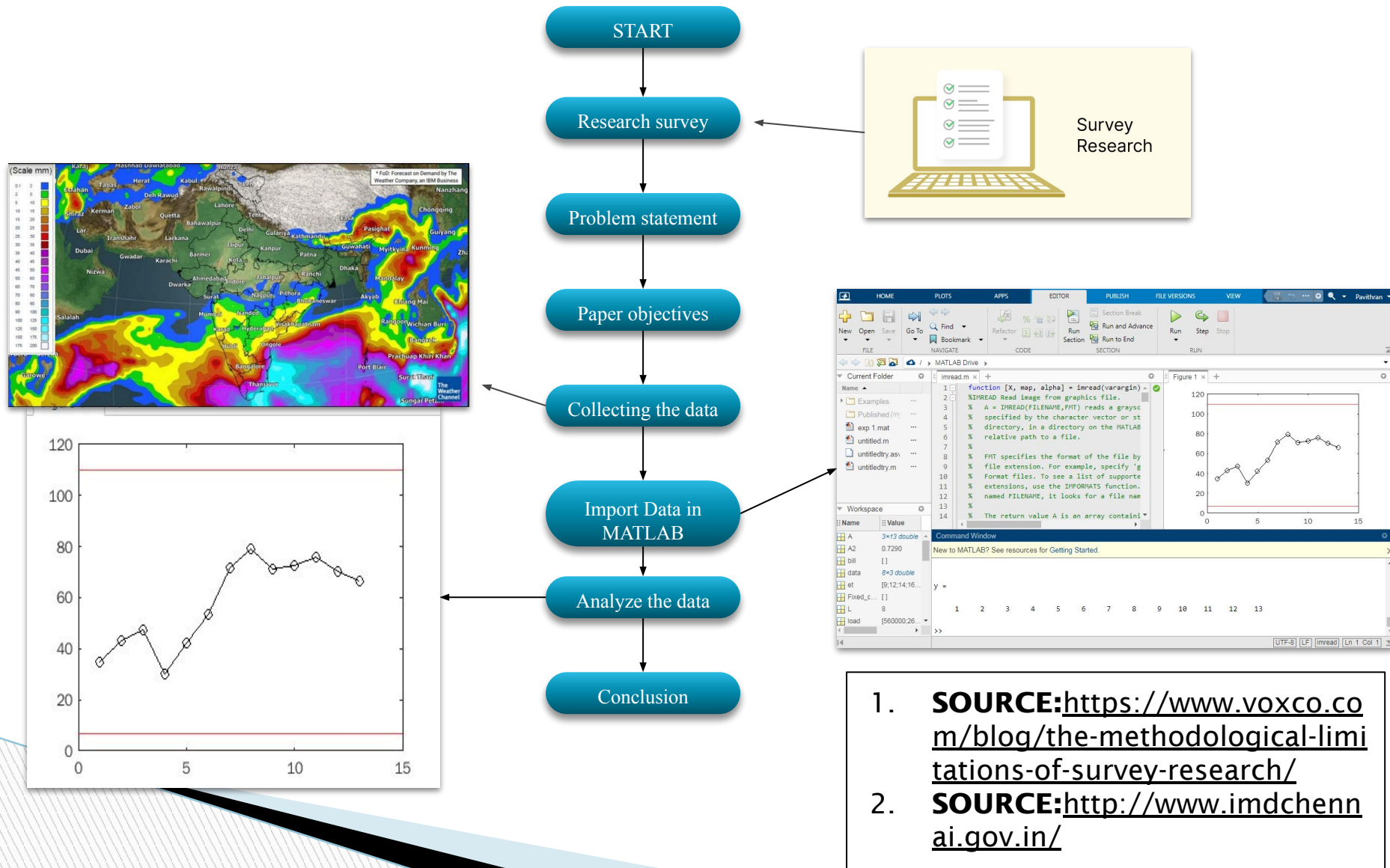
## Literature review

S.N O	Authors Names	Title of the Journals & Journals publishes & Year	Inferences
3	B.P.Mahesh, M.S. Prabhusamy	<p>Process variability reduction through statistical process control for quality improvement</p> <p>International journal for quality research, short scientific paper</p> <p>2003</p>	<p>It is used to improve the production system quality efficiency which gives tangible benefits in the shortest possible time for any organization</p>

## Literature review

SL.N O	Authors Names	Title of the Journals & Journals publishes & Year	Inferences
4	Dr.D.R.Prajapat hi Pranay s parmar Vivek A.Deshpande,	Implementation of SPC Techniques in automotive industry Implementation of statistical process control (SPC)  International journals for emerging technology and advanced engineering Journal for emerging technologies and innovative research 2012,2014	<ul style="list-style-type: none"> <li>•It is used for statistical tools to observe the performance of the production process in order to predict significant deviations that may later result in rejected product.</li> <li>•It is used for the result of a variation in some stage of production. The concept of variation states that no two products will be perfectly identical even if extreme care is taken to make them identical</li> </ul>

# Flow Chart



# Statistical Process Control (SPC)

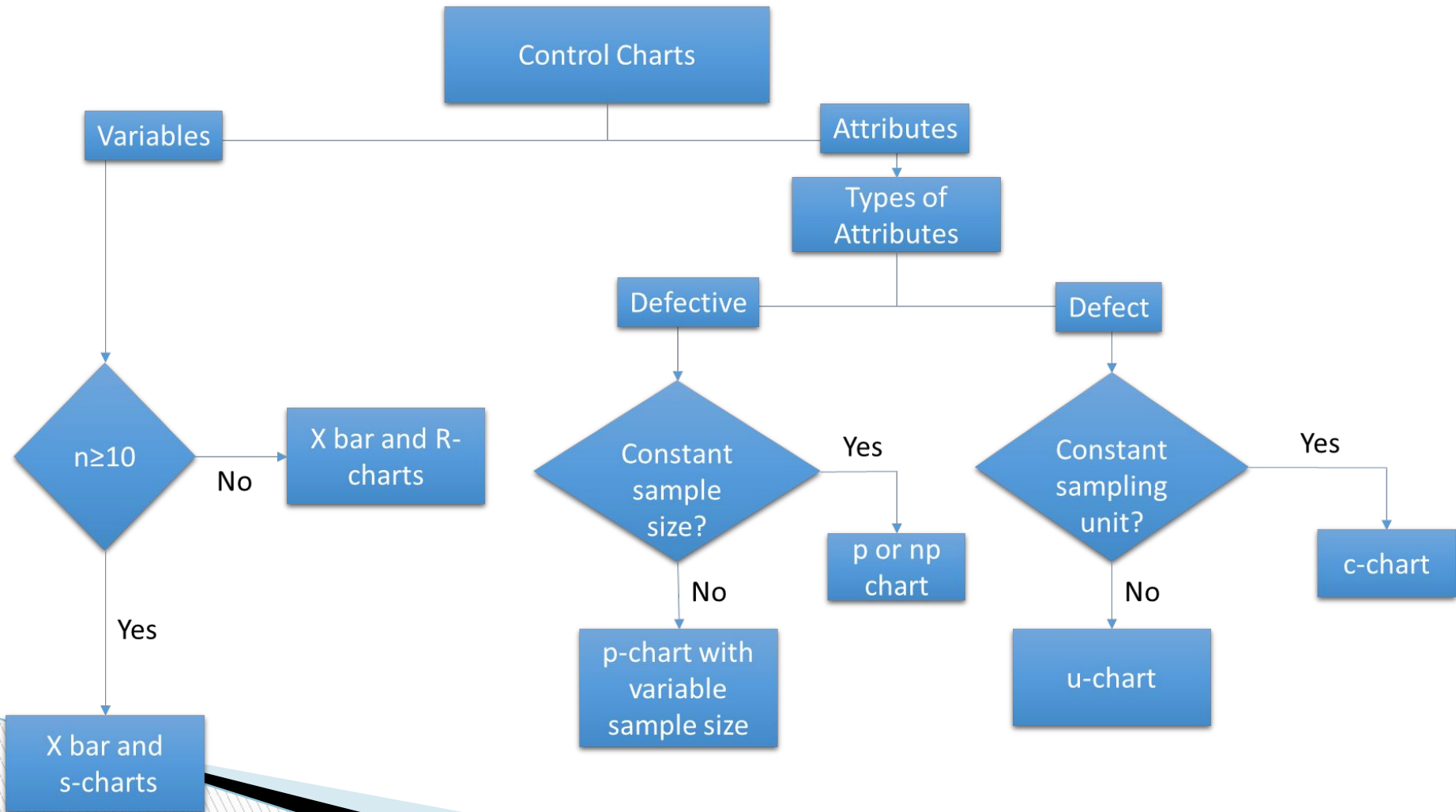
- It is the best technical tools for service quality is statistical process control (SPC).
- (SPC) is a technique used within the TQM framework for reducing variation in processes.
- In this tool for identifying problems and make improvements.

## Control charts

- A control chart is a graph that displays data taken over time and the variations of this data.

Control charts for variables	Control charts for attributes
The quality characteristics which can be measured and expressed in specific units of measurements are called variables. Types of variables control charts are: X bar or average charts, R or range charts and s or standard deviation chart.	An attribute refers to those quality characteristics that conform to specifications or do not conform to specifications. Types of attributes control charts are: p chart, np chart, c chart and u chart.

# Methodology



# Types of SPC

## 1. X bar and range chart

The most common type of SPC chart for operators searching for statistical process control, the Xbar and Range chart, is used to monitor a variable's data when samples are collected at regular intervals. The chart is particularly advantageous when your sample size is relatively small and constant.

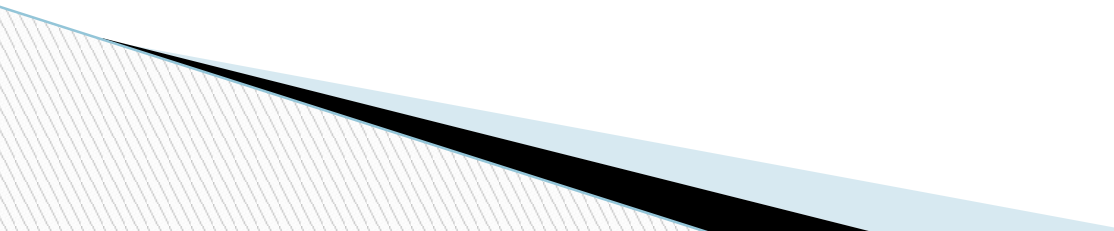
## 2. Individual x moving range chart

When it doesn't make sense to take multiple readings, the Individual-X Moving Range chart is the ideal option. This particular SPC chart is used to monitor variables data when it is impractical to use rational subgroups. "When data is very expensive or there is a whole lot of time between samples, the concept of Xbar and Range makes no sense," Wise explains. "It is better to go with Individual-X Moving Range

## 3. X bar and standard deviation chart

This chart is primarily used to show how much variation or "dispersion" exists from the average or expected value. The Xbar and Standard Deviation chart is touted for helping manufacturers, engineers, and operators understand variation better.

# MATLAB Usability:

1. Implement and test your algorithms easily.
  2. Develop the computational codes easily.
  3. Debug easily.
  4. Use a large database of built in algorithms.
  5. Process still images and create simulation videos easily.
  6. Symbolic computation can be easily done.
  7. Call external libraries.
- 



# IMD Reports

TABLE 1 IMD Weather Forecasting Report

SI. NO	Alerts	Locations in Tamil nadu	Rainfall /storm (mm/cm )	Actions
1	Red alerts	Chennai, Thootukudi, Ramanthapuram and Nagapattinam	25	Take action
2	Orange alerts	Niliris, Thenkasi, Dindigul, Theni	6 to 20	Be preapared
3	Yellow alert	Virudhunagar,Madurai, Thiruvanamalai, Villupuram, Chengalpat	5	Be alert

TABLE 2 - Cause effects in rainfall actions in 2021

SI.NO	No of days	Terms	Probability of occurrence	Category
1	Dec 21	Unlikely	< 25	Isolated (ISOL)
2	Dec 22	Likely	25 - 50	Scattered (SCT/ A few places)
3	Dec 23	Very likely	50 - 75	Fairly widespread (FWS/Many places)
4	Dec 24	Most likely	> 75	Widespread (many places)

source: <http://www.imdchennai.gov.in/>

TABLE 3 Winter Monsoon Rainfall 2021

source: <http://www.imdchennai.gov.in/>

Sl.NO	Places in Tamilnadu	Actual in mm	Normal in mm	PDN
1	Ariyalur	77.7	19.1	307
2	Chengalpet	31.2	14.5	201
3	Chennai	10	35	22
4	Coimbatore	22.6	24.7	43.4
5	cuddalore	38.3	45.7	55
6	Erode	48.8	45.3	57.2
7	Nammakal	35.8	32	78.0
8	Coimbatore	55	11.6	89
9	Madurai	89.2	12.5	29
10	Sivagangai	49	34.5	57.8
11	Virudhunagar	55.3	24.7	67.9
12	Thenkasi	23.5	44	25.7
13	Ramnad	1.1	43	37.9
14	Tuticorin	44.3	26.3	66
15	Kanyakumari	38.5	22.9	69
16	Villupuram	45.9	32.6	98
17	Karur	86.7	23	201
18	Dindigul	66.2	19.6	232
19	Pudukottai	74.3	16.7	372
20	Tirupur	34.9	17.9	300.7
21	Dharaapuram	80.1	26.8	145.5
22	Nilgiris	56	23	43
23	Kallakurichi	46	34	34
24	Kanchipuram	27	50	33
25	Ranipet	67	42	46
26	Salem	87.4	7.8	77
27	Theni	77	5.6	48
28	Thanjavur	34	4.1	44
29	Tirichy	28	48.7	89
30	Tirupattur	55	5.6	66
31	Thiruvallur	88	11	98
32	Thiruvannamalai	111	12	231
33	Vellore	121.5	24.5	167
34	Villuppuram	105	44.3	189
35	Krishnagiri	121	23	79
36	Nagapattinam	128.6	52.1	80

From the readings,

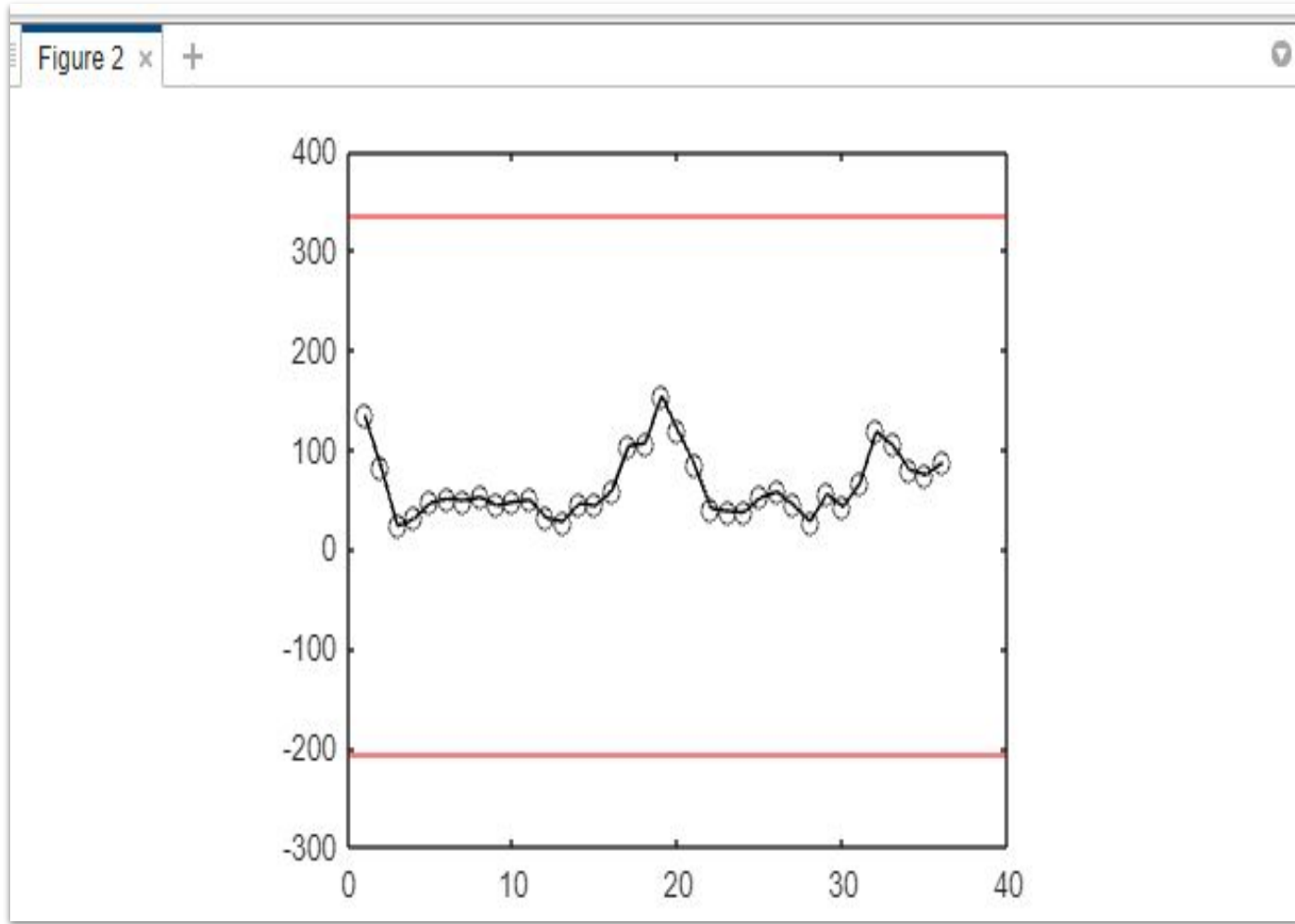
- Upper control limit = 372
- Lower Control limits = 29
- Control limits = 78
  
- Actual – Maximum 128.6  
Minimum 1.1,
  
- Normal – Maximum 52.1  
Minimum 4.1
  
- PDN –Maximum 372  
Minimum 29
- \*PDN – percentage departure from nominal

# Analytical solution using MATLAB

```
x1=input("enter the input x1");
x2=input("enter the input x2");
x3=input("enter the input x3");
x=(x1+x2+x3)./3
A=[x1; x2; x3;]
M=mean(x)
S=sqrt(var(x))
Mx=max(A)
Mi=min(A)
R=Mx-Mi
Rbar=mean(R)
y=1:1:max(size(x))
A2=0.729;
plot(y,x,'-k')
hold on
plot(y,x,'ok')
yline(M+(A2*Rbar), 'r')
yline(M-(A2*Rbar), 'r')
```

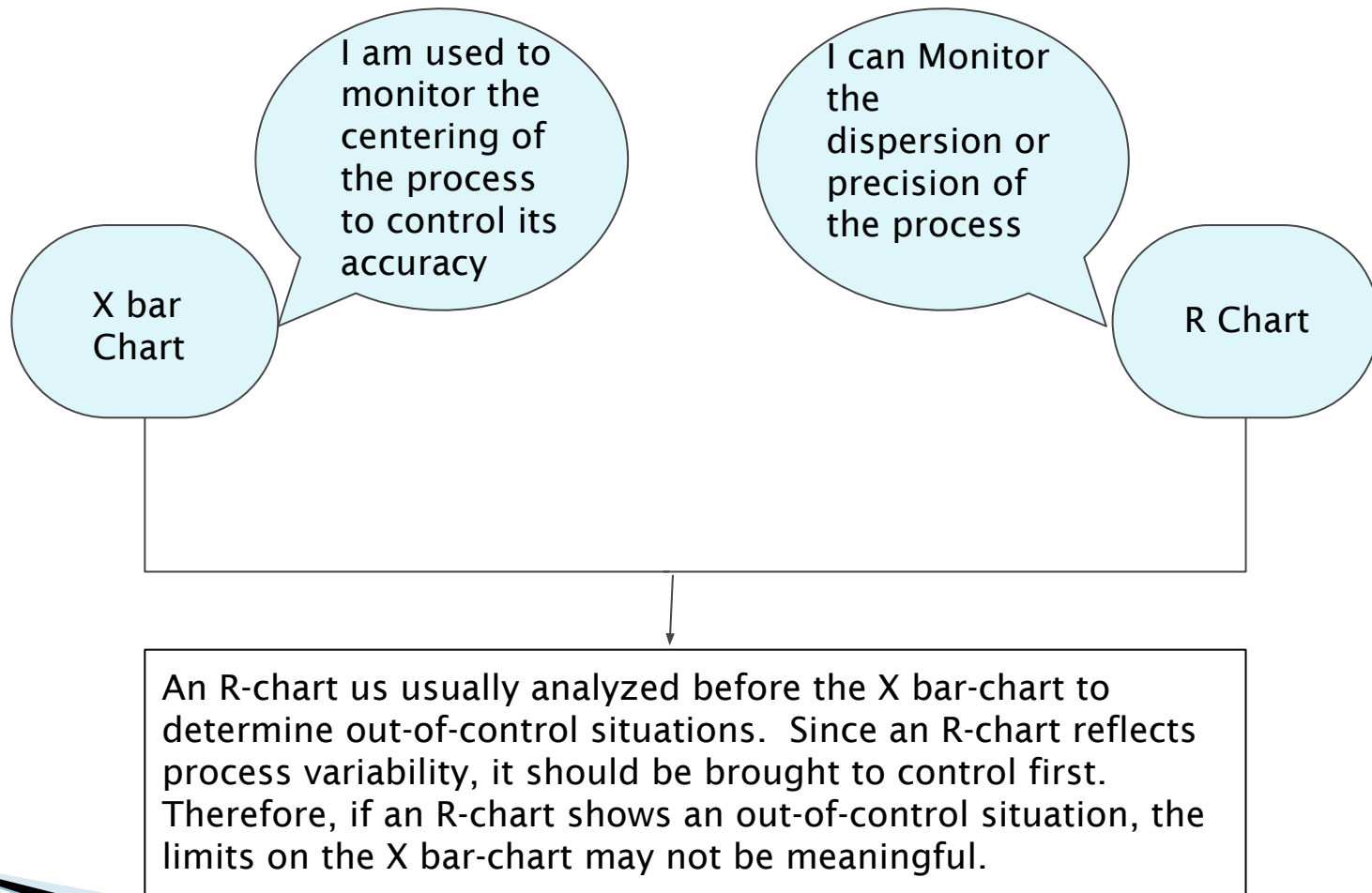
# Analytical solution using MATLAB

PDN value



Normal value

# X bar and R chart



# Result

- From Winter Monsoon Rainfall 2021
- it clearly shows the rainfall happened in the year is highly than previous year.
- This time it caused huge disasters.
- By applying the concept in the paper is helps the people in future to shows the storm rate in all over the districts in tamilnadu for avoiding collateral



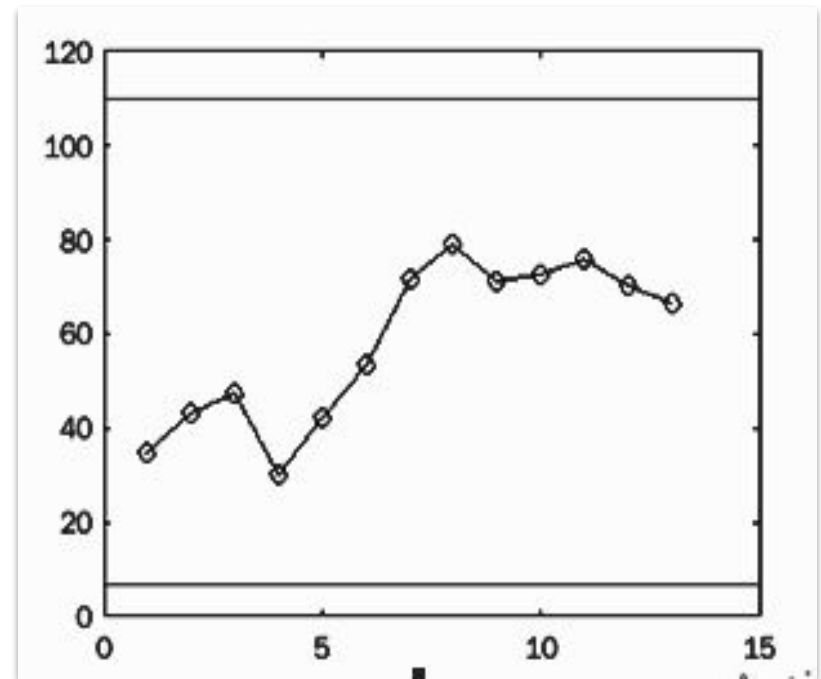
Source: [https://en.wikipedia.org/wiki/Cyclone\\_Burevi](https://en.wikipedia.org/wiki/Cyclone_Burevi)

# Result:

□ By analyzing the various data in meteorological department. We here generated the following chart and there by results are obtained.

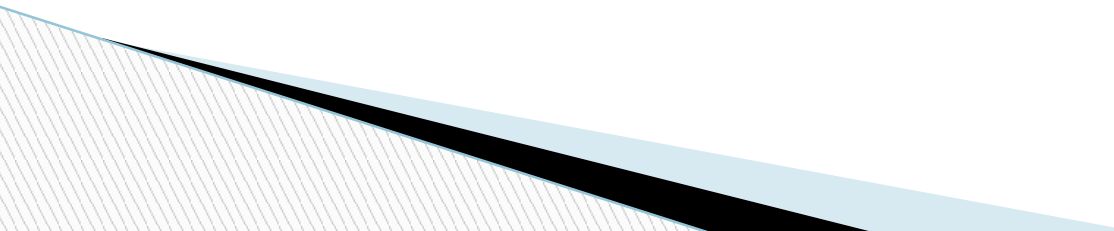
- $M = 58.50$  (Mean value)
- $R \text{ bar} = 70.64$  (Range)
- $S = 17.09$  (standard deviation / Sample)

From this figure , x axis is (R), y axis is (S), Centre (M)





# Conclusion

- ❑ From the above study it can be concluded that basic requirement of the weather forecasting.
  - ❑ Forecasting variability is studied and then the statistical process control is implemented and monitored.
  - ❑ The control chart used here is to study how the process changes over time and by comparing the data to draw conclusion about weather measurement value exceeding the region of tamil nadu.
  - ❑ On taking into the consideration of different sampling measurement and sampling interval the graph was plotted in the MATLAB Software
- 

# Future Scope

- In the future, we will monitor the different regions for storms. This will help in identifying weather problems in different places.
- Currently this paper focused on 1 week reading of rainfall, hereafter we will take and implement of years of reading.
- Based on the meteorological centers, data will be collected so it can help predict future problems at certain intervals.

source: <http://www.imdchennai.gov.in/>

Tamil Nadu Rainfall (mm) - January			
Year	Normal	Actual	Deficient / Surplus
2014	17.5	7.4	-58%
2015	17.5	8.3	-53%
2016	17.5	2.5	-86%
2017	17.5	37.3	113%
2018	17.5	6.3	-64%
2019	15.5	2.1	-84%
2020	15.5	9	-42%
2021 (till Jan 14)	10.8	124.8	1055%

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- [1] Gurusahab singh missan and Dr.I.P. Kswani , “Analysis of Causes of Engine overheating due to cooling system failure using pareto principle”, International journals of Engineering trends and Technology volume 36, Number 5, June 2016
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Thank you

