INDUSTRIAL & SYSTEMS ENGINEERING
TEXAS A&M UNIVERSITY

Multivariate Phase 1 Analysis for monitoring manufacturing process

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Problem Summary

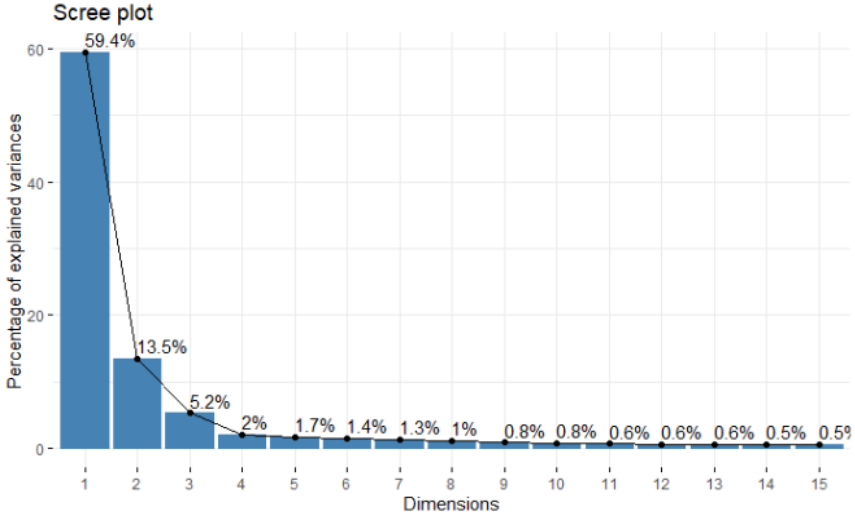
- **Objective** :- To identify the in-control data points and eliminate out-of-control data points to set up distribution parameters for the future monitoring of underlying manufacturing process.

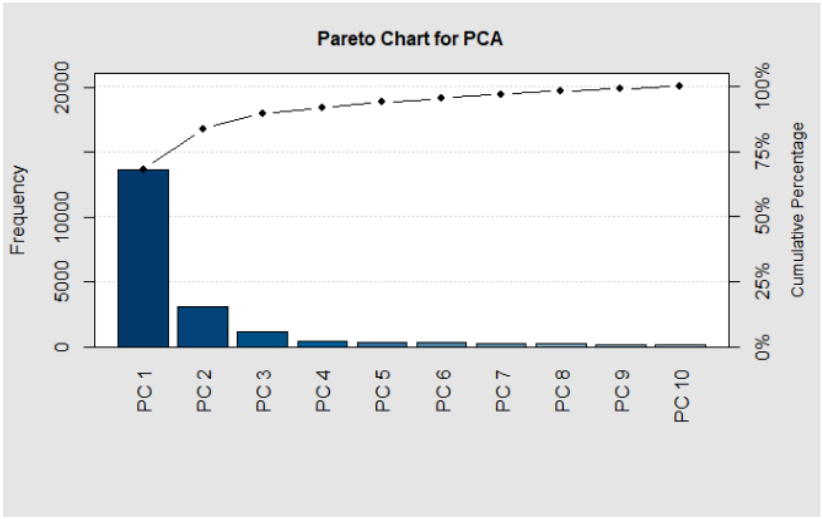
- Data Characteristics :-
  - Number of variables, p = 209
  - Total number of data records, m = 552
  - Sample size, n = 1

Methodology

1. Reduce the data dimension using PCA to capture maximum variability while keeping number of variates low.
2. Use Hotelling T^2 charts to remove large spikes within the data until we get no outliers on T^2 charts.
3. Use m-CUSUM charts to remove small sustained mean shift until we get no outliers on m-CUSUM charts.
4. Iterate between Hotelling T^2 charts and m-CUSUM charts to remove all of the out-of-control data points.

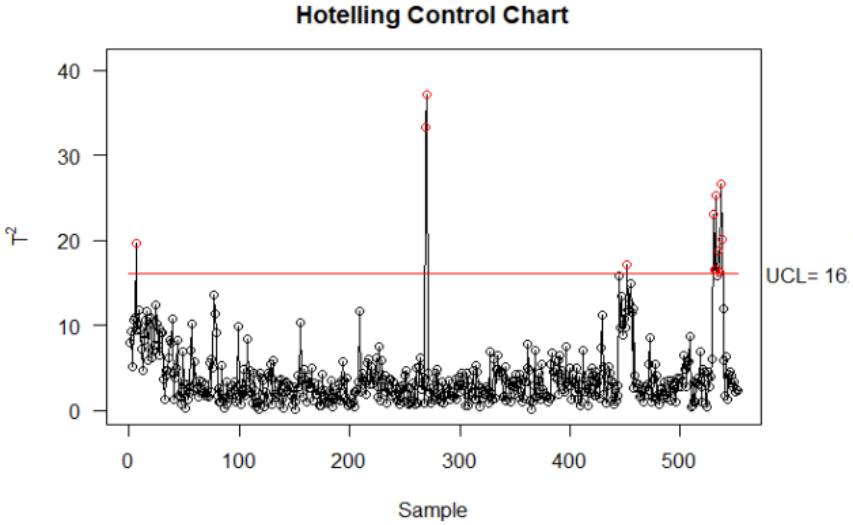
Scree plot and Pareto plot for selection of Principal Components



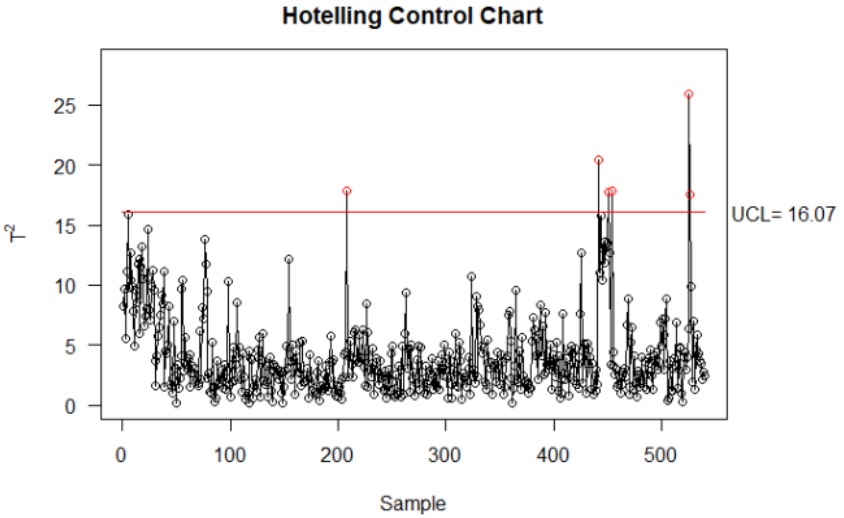


- Based on above plots, we selected total 4 Principal Components which explain more than 80% of variance.

T^2 charts developed during first 2 cycles of 1st iteration

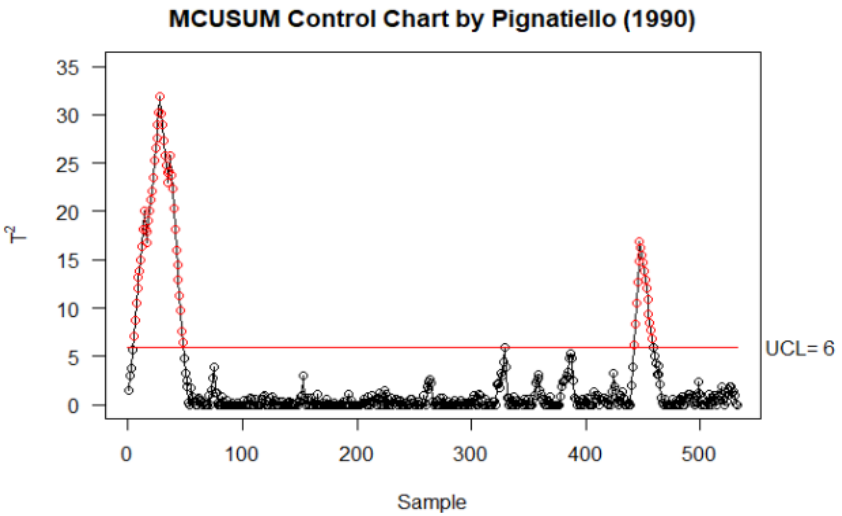


- Iteration: 1
- Cycle: 1
- UCL: 16.07
- Out of control points: 12

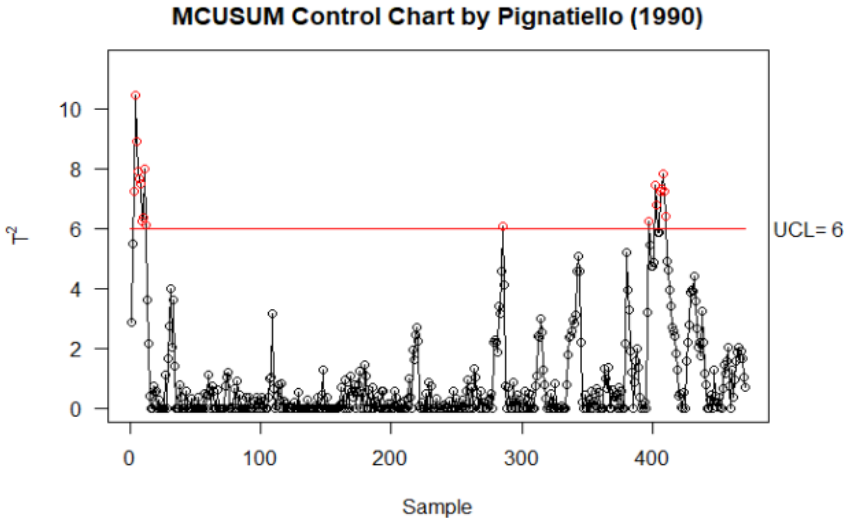


- Iteration: 1
- Cycle: 6
- UCL: 16.07
- Out of control points: 12

m-CUSUM charts developed during first 2 cycles of 1st iteration



- Iteration: 1
- Cycle: 1
- UCL: 6
- Out of control points: 61

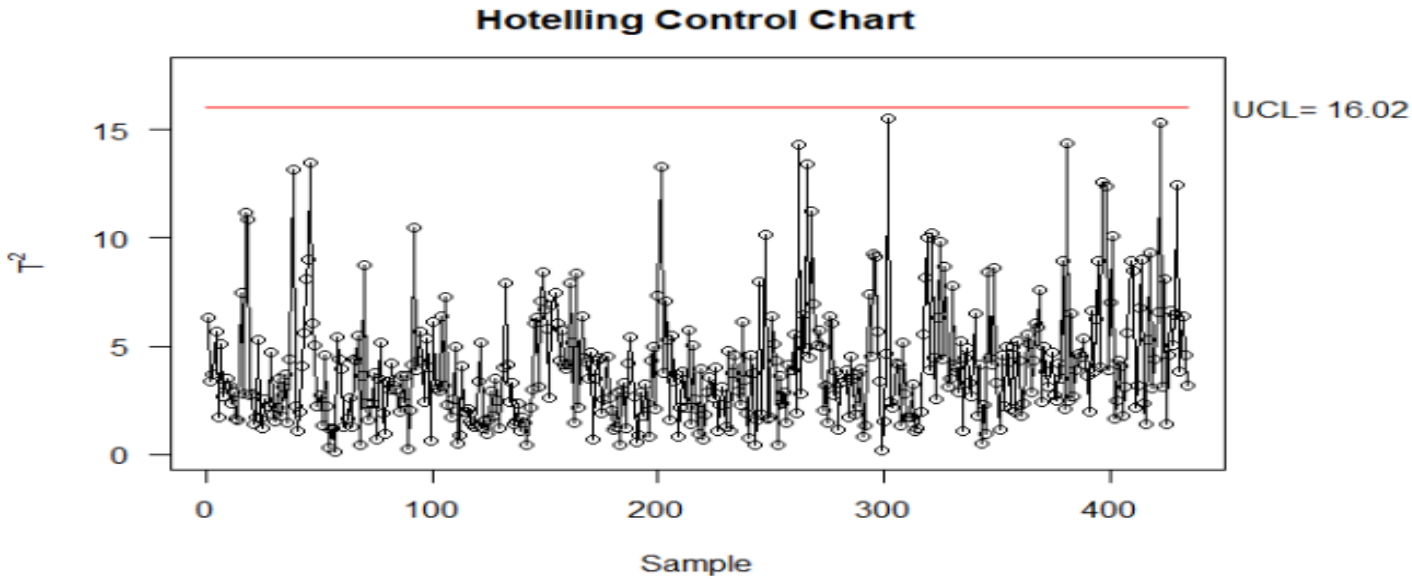


- Iteration: 1
- Cycle: 2
- UCL: 6
- Out of control points: 19

Phase 1 Analysis Results

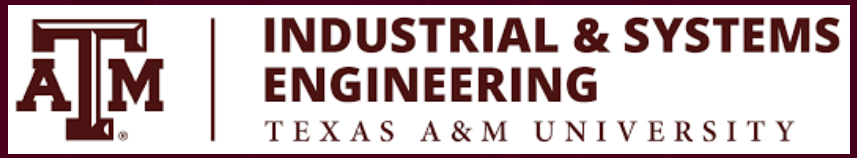
Sr. No.	Control Chart type	Iteration	Total Data points removed
1	T^2 Chart	1	20
2	m-CUSUM Chart	1	90
3	T^2 Chart	2	8
4	m-CUSUM Chart	2	0

Final Hotelling T^2 chart with established UCL for phase-2 analysis



Conclusions

- Total number of data points: 552 and Total number of variables: 209
- Total number of selected principal components: 4 (Explained variance is > 80%)
- Total number of in-control data points present in the dataset: 434
- Total number of out of control data points detected during phase 1 analysis: 118
- UCL obtained for Hotelling T2 chart after Phase 1 Analysis: 16.02
- Established mean and variance matrices for Phase 2 Analysis and future monitoring of manufacturing process.



Thank You!