EMIS 7357
Systems Quality Engineering

Case Study

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Summary

Quality control is the act of ensuring that a company's goods and services are built and delivered to spec, on time and at the appropriate cost. It is a crucial part of managing a successful company. If customers receive or perceive inconsistent products and services, they will stop coming or become less loyal. For this reason, a variety of management strategies, including just-in-time manufacturing total quality management (TQM) and six sigma have been developed to help companies produce higher-quality products.

The goal of this project is to assess the cleaning process was done before the yarn formation. We have 6 lines of production that we have to check for the quality purpose. We are going to perform 3 quality checks at the bale level, after cleaning process and one after sliver formation which is stage before formation of yarn.

Introduction

Here we have a to analyse a data set of textile industry for the different process (processing of cotton) which is provided by USDA (United States Department of Agriculture. They have provided information on various physical attributes of cotton such as length, strength, uniformity, color, trash content, micronaire etc. within the bale and between the bales. The cotton bales are not processed at one time there are several different processes that are as follows:

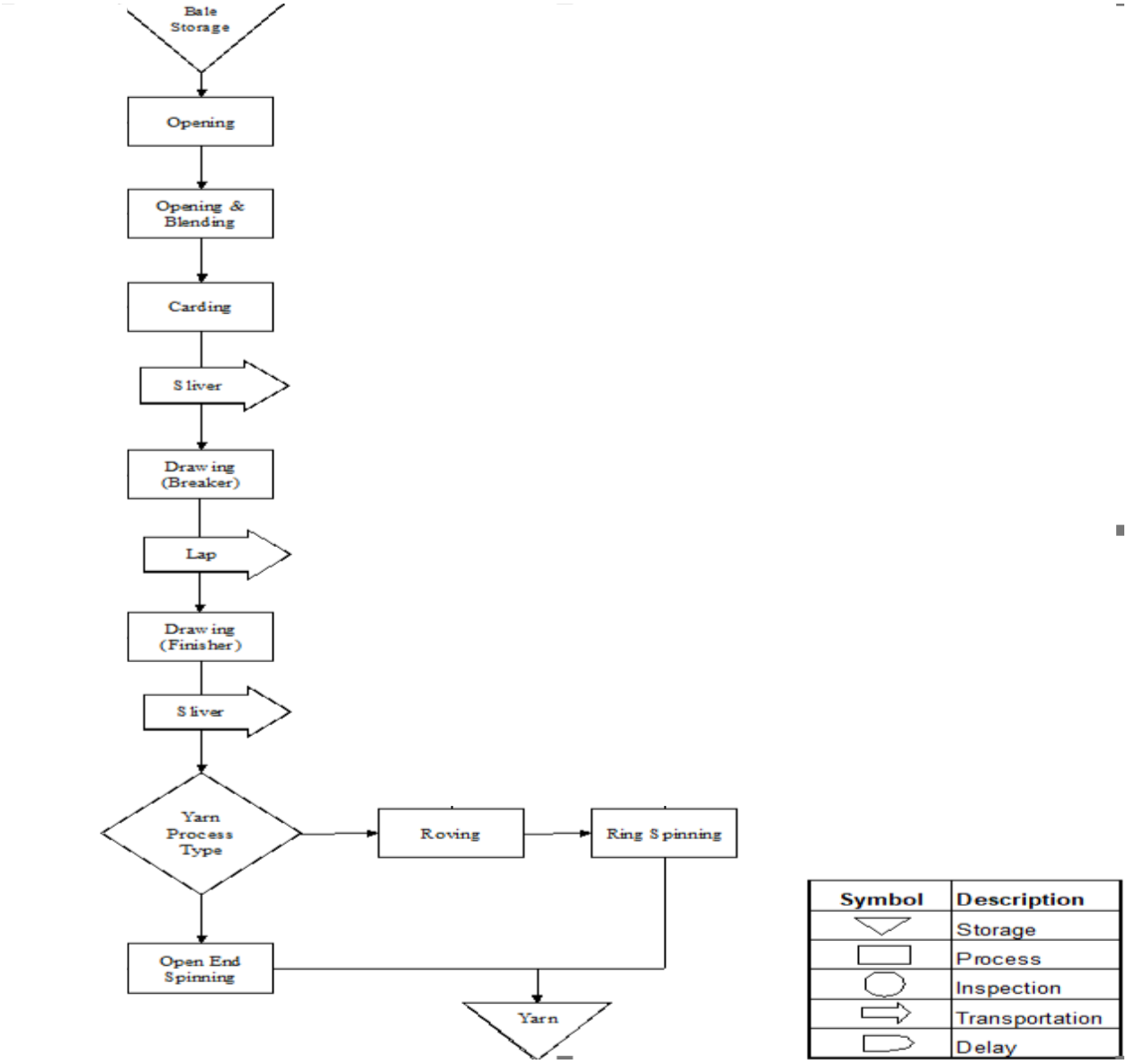


Fig.1 Process flow diagram

The process are is follows according to the figure 1 .

1. Bale Storage:
   They are processed in groups ranging from six to 100 bales, depending upon the opening and blending system. The laydown process is crucial for eliminating fiber variation found between individual bales. After bale selection, the bales are brought into a preparation area, and the straps and covering material are removed.) . They are transferred to a staging area (or blow room). The blow room temperature is important.
2. Opening:
   Opening process removes a group of fibers from each bale in the laydown and conveys them to a blending and cleaning machine.
3. Opening and Blending:
   Blending is simply mixing the fibers by a layering and tumbling action inside a large metal box. Heavy objects and pieces of wire or metal are removed at this stage of cleaning. Cleaning equipment is designed to remove trash, dust, and other impurities.
4. Carding :
   The carding process is basically fiber alignment, cleaning, and forming into sliver.At the end of the carding process nep reduction, short fiber reduction, and decrease in trash content is obtained. Carding machines process cotton at a slow rate as low as 45 kg/h (100 lb/h). Thick or thin places on the sliver will result in uneven yarn. This is why fiber mass control is crucial at the carding process.
5. Sliver:
   Sliver in yarn production, loose, soft, untwisted ropelike strand of textile fibre having a roughly uniform thickness. It is produced by the carding process, which separates raw fibres to prepare them for spinning.
6. Drawing:
   Drawing process blends, straightens, and levels the slivers. Usually six or more slivers from carding machines are pulled through the drawing process at the same time. This way slivers from different carding machines are blended and mixed.
7. Lap:
   Combing is required for high quality yarn products. For this process slivers are run through the machine called a lapper to form lap from several slivers. By the end of combing more short fibers are removed, and fibers are more straighten and blended. Maintaining laps weigh at 1050 grains per yard is important. The waste after the lap formation is approximately 0.25% per weight, and it is considered as reworkable and salable.
8. Drawing (Finisher):
   The final drawing process produces about 0.10% per weight reworkable waste. After final drawing the yarn spinning process takes place. Spinning type is determined by the desired properties of the yarn product and the required properties of the fiber to be processed
9. Sliver

10. Yarn Process
11. Roving:
    If the end product is expected to be the strongest, finest, and softest yarn, ring spinning is performed. Roving is preparatory stage for ring spinning process
12. Ring Spinning:
    Rotor spinning produces weaker yarns than ring spinning. The yarn count range is limited (few types of yarns). The fiber is formed into yarn by means of twisting with “s” rotating rotor. Rotor spinning has a high production capability. Because there are no additional steps to production, the cost is low compared to ring spinning.
13. Open end Spinning
14. Yarn

Quality Control Analysis

In this whole process we are going to perform three quality checks to assess about the process. Our first quality check is the bale level at the opening process, second quality check is done after cleaning process on each line separately and the third last quality check is done after sliver formation before the yarn formation.

Quality check 1

First quality check is at the bale level at the opening process (Bale line1, Bale line2,….). So here we have taken account of Dust, Trash and SFC%. We analysed these data according to the bale lines (1-6) and assuming some factors. We used R, S and Xbar control charts and calculated Cp and Cpk. We used these charts as other charts required some additional information and our data were not satisfying the need in the terms of subgroups and some other factor of the charts to obtain a desired output to analyse the data and comment over the process
Assumptions:

1. The value for the constants used for the charts are A2=0.153, D3=0.459, D4=1.54,B3=0.5656 and B4=1.435.

SFC% Analysis:

Dataset for SFC % Analysis taken for 6 different bale lines as shown in figure.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	xbar	r	s
9.5	5.4	8.6	9.7	8.4	8.9	8.4	14	6.5	10.9	8.1	9.6	7.6	11.3	11.6	8.8	9.4	9.2	10.3	6.1	10.1	14.5	11.9	8	15.8	9.70	10.4	2.497412
11.5	11.6	12.2	10.9	12.5	11.4	11.1	9	8.5	7.7	19.2	9.4	15.4	16.6	16.4	16.7	12.2	12.2	13.5	14	11.6	12.8	12.5	11.8	11.3	12.48	11.5	2.7213661
8.1	10.8	6.2	6.2	9.5	10	5.6	6.5	9.7	9.6	6.3	10.3	8.5	5.8	9.1	7.4	8.1	8.4	5.3	9.8	11.4	8	7.6	11.9	9.2	8.37	6.6	1.8762818
8.2	9.5	10.3	6.7	6.2	8.5	7.4	10.8	7.4	5.2	9.2	8.5	9.5	6.6	9.6	6.8	6.7	11.2	11.2	10.6	6.5	9.2	10.1	16.4	16.7	9.16	11.5	2.804015
11.9	9	8.8	15.1	11	8.3	7.4	8.1	12.7	11.6	8.1	9.6	9.9	10	8.7	9.9	6	8.6	11.1	13.5	13.9	9	8	8	9.4	9.90	9.1	2.2118017
14.7	8	10.6	11.5	8.4	7.2	9.6	7.4	11.9	10.6	10.2	7	11.2	16.4	14.7	11	5.9	7.5	6.2	13.2	9.5	7	5.3	6	8.4	9.58	11.1	3.0115445
																								average	9.87	10.033333	2.5204035

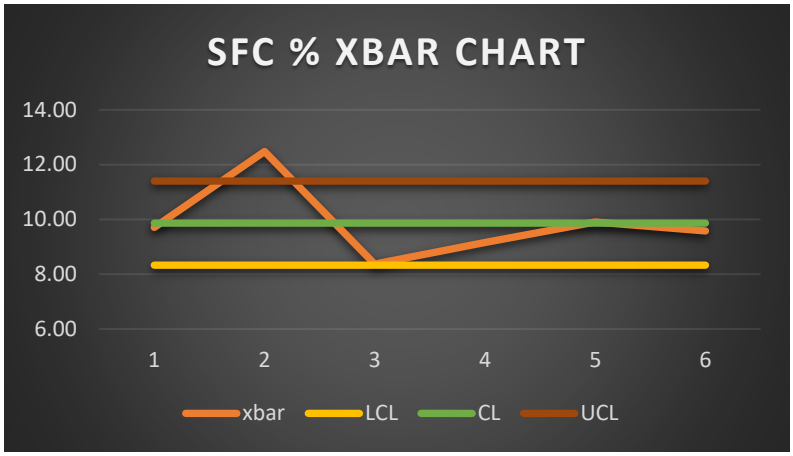
Rchart			Xbar chart			Schart		
LCL	CL	UCL	LCL	CL	UCL	LCL	CL	UCL
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779
4.6053	10.03	15.451333	8.3309	9.87	11.4011	1.4255402	2.52	3.616779

The X-Bar chart shows how the mean or average of SFC% for 6 bale line changes Here we have

X-BAR chart for SFC% chart which shows that Bale line 2 is out of the upper control limit which is 11.4011 as you can see determine the limits for the charts & the bale line 3 is almost on the verge of going out of lower control limit .

Further the Bale line 2 is out of the limit because of few short fiber content percentages in the bale line 2. The data that was causing problem are for the dates 6/9/2004 - 19.2, 7/14/2004 - 15.4, 7/28/2004 – 16.6 , 8/11/2004 – 16.4 , 9/13/2004 -16.7 , 1/24/2005 – 13.5 , 3/7/2005 – 14 and 5/9/2005 – 12.8 and I verified the process by eliminating the data for the similar date and watch the process if its in control or not.

The reason that causes the cotton bale SFC % out of control for bale line 2 is because during these dates the weather was rainy, or moisture content was high as the soil where cotton grows cant sustain high moisture content as it starts affecting the cotton. This may be one reason for the same.



Dust Analysis:

Dataset for Dust Analysis taken for 6 different bale lines as shown .

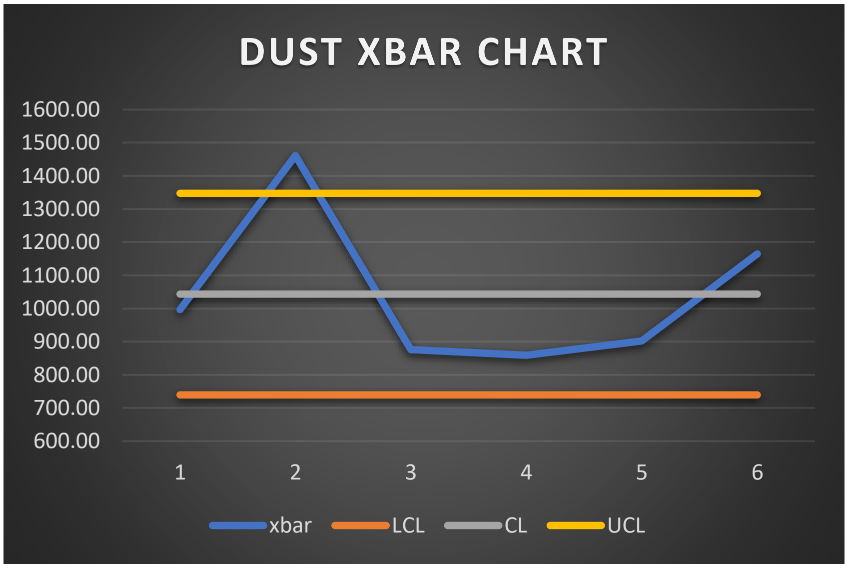
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	xbar	r	s
9.5	5.4	8.6	9.7	8.4	8.9	8.4	14	6.5	10.9	8.1	9.6	7.6	11.3	11.6	8.8	9.4	9.2	10.3	6.1	10.1	14.5	11.9	8	15.8	9.70	10.4	2.497412
11.5	11.6	12.2	10.9	12.5	11.4	11.1	9	8.5	7.7	19.2	9.4	15.4	16.6	16.4	16.7	12.2	12.2	13.5	14	11.6	12.8	12.5	11.8	11.3	12.48	11.5	2.7213661
8.1	10.8	6.2	6.2	9.5	10	5.6	6.5	9.7	9.6	6.3	10.3	8.5	5.8	9.1	7.4	8.1	8.4	5.3	9.8	11.4	8	7.6	11.9	9.2	8.37	6.6	1.8762818
8.2	9.5	10.3	6.7	6.2	8.5	7.4	10.8	7.4	5.2	9.2	8.5	9.5	6.6	9.6	6.8	6.7	11.2	11.2	10.6	6.5	9.2	10.1	16.4	16.7	9.16	11.5	2.804015
11.9	9	8.8	15.1	11	8.3	7.4	8.1	12.7	11.6	8.1	9.6	9.9	10	8.7	9.9	6	8.6	11.1	13.5	13.9	9	8	8	9.4	9.90	9.1	2.2118017
14.7	8	10.6	11.5	8.4	7.2	9.6	7.4	11.9	10.6	10.2	7	11.2	16.4	14.7	11	5.9	7.5	6.2	13.2	9.5	7	5.3	6	8.4	9.58	11.1	3.0115445

LCL	CL	UCL	LCL	CL	UCL	LCL	CL	UCL
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305
911.9565	1986.83	3059.72333	739.381167	1043.37	1347.35217	267.924643	473.70	679.759305

The X-Bar chart shows how the mean or average of Dust for 6 bale line changes Here we have X-BAR chart for Dust which shows that Bale line 2 is out of the upper control limit which is 1347.35 as you can see determine the limits for the charts above and the bale line 3 is almost on the verge of going out of lower control limit .

Further the Bale line 2 is out of the limit because of dust content in the bale line 2. The data that was causing problem are for the dates 3/31/2004 - 1863, 1/24/2005 - 3061, 5/9/2005 – 3051 , 8/29/2005 – 1873 and I verified the process by eliminating the data for the similar date and watch the process if it’s in control or not.

The reason that causes the cotton bale dust content out of control for bale line 2 is because during these dates the weather was windy and there are dates which are similar with the SFC % where the bale line 2 was out of control because of rainy weather , it might have also caused thunderstorm (wind blowing at high speed) due to which dust content was high on the similar dates. These may be one of reason for the same.



Trash Analysis:

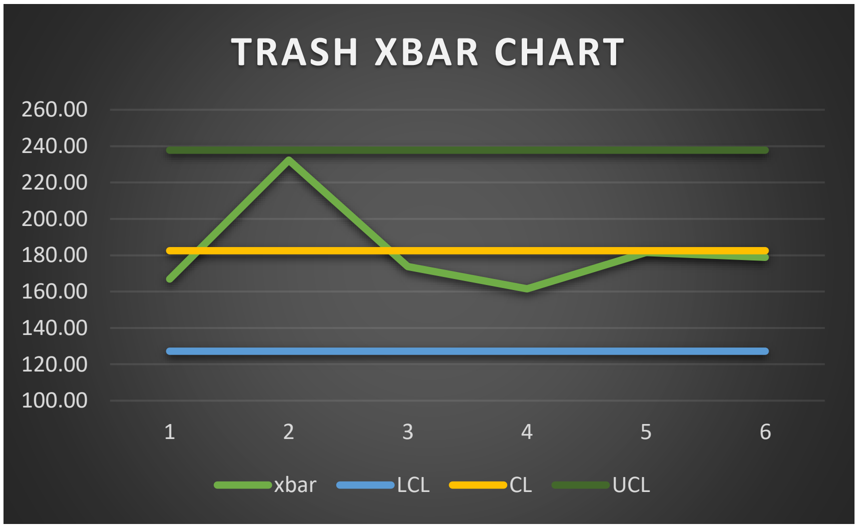
Dataset for Trash Analysis taken for 6 different bale lines as shown in figure.

1	2	3	4	5	6	7	8	9	10	11	12	13
117	237	159	198	116	108	130	238	248	226	178	157	89
159	218	155	273	137	329	104	163	235	192	204	253	229
93	96	137	195	242	170	191	88	131	113	334	110	331
113	99	83	99	246	157	131	49	170	279	186	61	221
157	128	270	101	97	152	346	549	118	149	148	163	72
202	458	52	196	147	383	117	207	201	74	185	70	227

14	15	16	17	18	19	20	21	22	23	24	25	xbar	r	s
76	65	171	135	70	87	138	236	217	203	440	135	166.96	375	81.0732591
324	278	183	235	209	439	190	205	476	133	214	271	232.32	372	87.9387666
289	145	121	161	67	55	201	146	184	223	319	203	173.80	279	80.4228409
156	186	169	223	89	101	170	204	266	131	141	308	161.52	259	68.9777259
338	105	168	193	104	72	204	159	128	145	255	217	181.52	477	105.469237
248	257	241	159	69	74	191	204	158	63	146	141	178.80	406	96.4360755
											AVERAGE	182.49	361.333333	86.7196509

LCL	CL	UCL	LCL	CL	UCL	LCL	CL	UCL
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699
165.852	361.33	556.453333	127.202667	182.49	237.770667	49.0486345	86.72	124.442699

The X-Bar chart shows how the mean or average of trash for 6 bale line changes Here we have X-BAR chart for trash which shows that Bale line 2 is on the verge of going out of the upper control limit which is 237.77 as you can see determine the limits for the charts from the figure above. Further the Bale line 2 is almost on the verge of going out of the limit because of trash content in the bale line 2. The data that might cause problem in future is are for the dates 5/9/2005 – 476.



Conclusion:

After the first quality check the I can say that for SFC% and dust content just because of the cotton bales at the bale line 2 is going out of control, as we talked about the weather which can be one of the major reason for the same and the other reason might be that all the cotton bales bought are from different regions that's why the weather conditions are different that makes bale 2 to be different from others.

Quality check 2 :

Second quality check is done after opening& blending, carding and then sliver process on each line separately (Mat1.1, Mat2.1....).. So here we have taken account of Dust, Trash , NEP, SFC%. We analysed these data according to the Mat(1-6) and assuming some factors. We used R, S and Xbar control charts and calculated Cp and Cpk. We used these charts as other charts required some additional information and our data were not satisfying the need in the terms of subgroups and some other factor of the charts to obtain a desired output to analyse the data and comment over the process

Assumptions:

1. Assuming for bale line 1 there is mat1.1, mat1.2….mat1.9
2. Also assuming the process is going with the similar dates with the bale lines
3. The value for the constants used for the charts are A2=0.153, D3=0.459, D4=1.54,B3=0.5656 and B4=1.435.

MAT 1:

Here I have assumed MAT 1 process is next process step for Bale line 1 , further MAT 1 have 9 machines for a single bale line 1 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

We concluded by looking at the graphs everything is in control with respect to bale line 1.

MAT 2:

Here I have assumed MAT 2 process is next process step for Bale line 2 , further MAT 2 have 9 machines for a single bale line 2 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart . Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

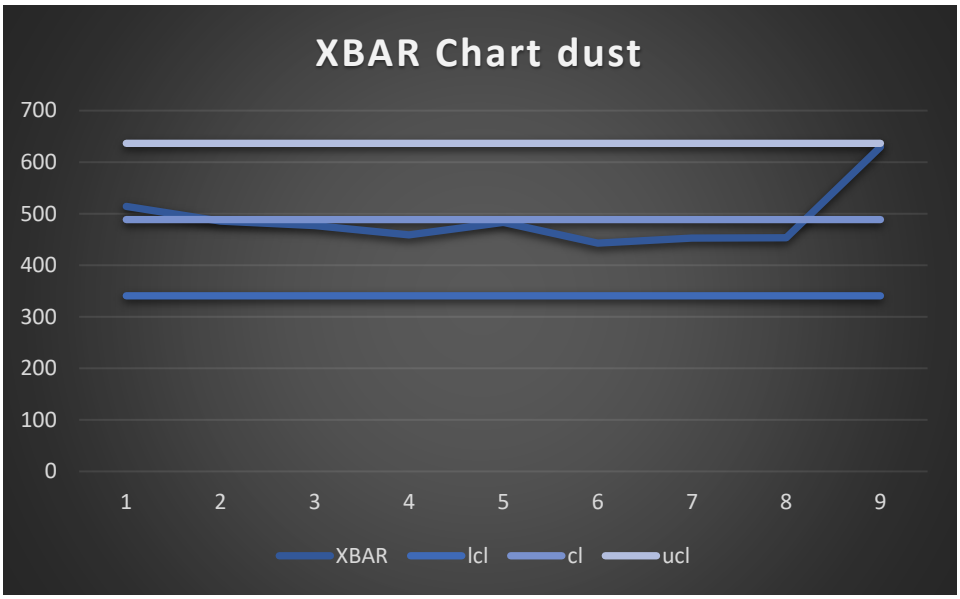
Dust Analysis :

Dataset for dust Analysis taken for 9 different MAT lines as shown in figure below. There is one data that is extremely high in comparison to all that is Mat 2.9 for the date: 12/6/2004 - 4967

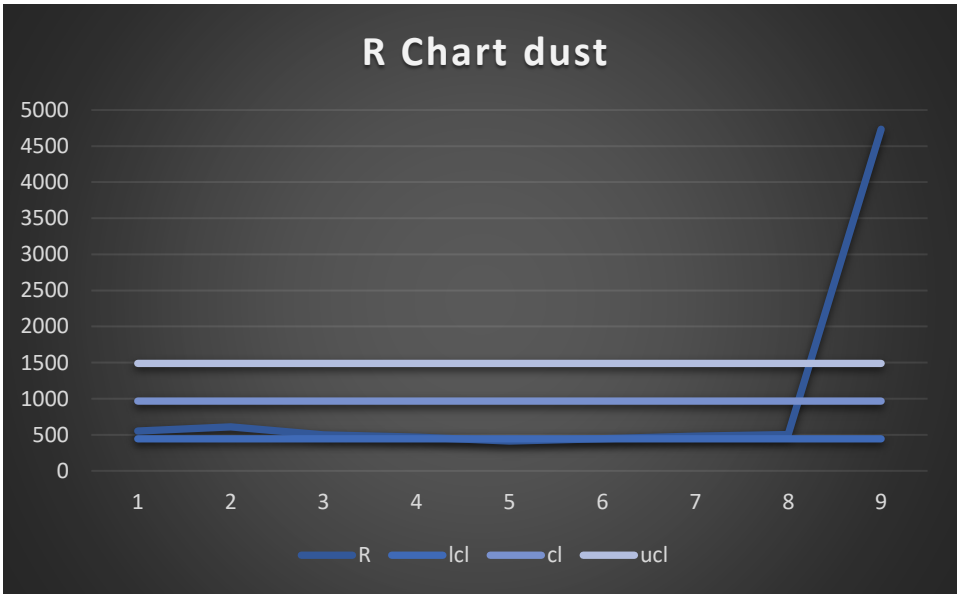
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	XBAR	R	S
571	464	376	573	363	545	232	358	335	299	784	645	655	579	721	551	549	558	560	523	531	628	436	593	433	514.48	552	133.864
539	325	406	463	351	505	254	414	208	221	741	617	817	614	538	459	339	495	388	630	570	525	525	633	560	485.48	609	152.96
538	376	331	573	323	628	210	397	290	325	708	656	658	487	441	495	457	482	524	477	587	459	414	555	531	476.88	498	124.94
404	471	353	431	341	582	235	347	201	385	669	540	663	594	461	473	369	469	460	472	416	453	482	621	581	458.32	468	119.306
599	447	409	411	351	507	274	490	290	259	573	555	672	483	574	457	555	530	530	571	461	561	479	466	570	482.96	413	104.944
495	408	405	501	387	561	225	309	259	307	669	482	535	475	453	509	413	481	552	322	473	405	447	543	458	442.96	444	102.393
463	511	436	489	269	484	269	339	186	311	593	514	665	553	396	503	319	503	421	457	549	451	497	590	557	453	479	116.269
455	469	325	428	355	451	228	310	298	329	668	475	733	578	532	485	485	444	503	486	467	421	371	495	545	453.44	505	113.323
435	380	388	396	368	455	233	307	249	299	787	497	600	566	547	399	399	4967	478	624	525	357	453	449	583	629.64	4734	912.307
																								AVERAGE	488.64	966.889	208.923

	lcl	cl	ucl	lcl	cl	ucl	lcl	cl	ucl
4	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
1	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
4	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
6	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
4	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
2	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
5	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
8	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804
7	340.706	488.64	636.574	443.802	966.89	1489.01	118.167	208.923	299.804

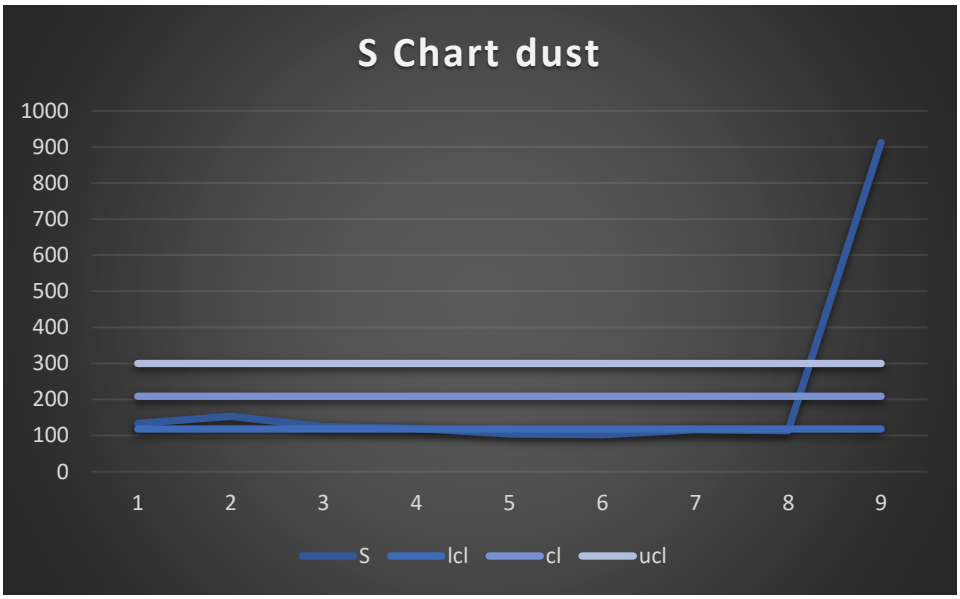
The X-Bar chart shows how the mean or average of dust for MAT 2 (2-9 mats for bale line 1). Here we have X-BAR chart for trash which shows everything in MAT 2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.8,2.9 is in control with respect to Bale line 2. The Xbar chart is shown below in figure above and refer the limits for the chart from shown above. Everything seems to be in control limits but the process is out of control due to a dust content in Mat 2.9 during 12/6/2004 , as at that time we have dust content of 4967 which extremely high and makes the process out of control. So assuming at that instant the Mat2.9 is malfunctioned which makes the process out of control if we eliminate that value then our process is in control. Even I checked back with the bale line 2 for the same date the dust content is in limits that's 1237. I can conclude by saying at that instance the Mat 2.9 is malfunctioned.



The R chart (subgroups for less than 9, used to see what happens to the range irrespective of subgroups)) shows the range of random sample over the period taken from all the MAT 2 lines with respect to bale line 2 in the process. The control R chart is shown in the figure.
While analyzing everything over the MAT 2 seems to be in control (refer the figure above for limits) except for Mat 2.9 and that makes the process out of control for the same reason as it might be malfunctioned at that point of time.



The S chart is used for subgroups more than 9 and I used it to see the variation of standard deviation in all the MAT 2 (1-9 in the mat 2) over bale line 2 over the time period. The chart is also in control and the trend line is almost similar to the R chart . The S chart is shown below Figure. The process seems to be out of control as it might be malfunctioned at that point of time.



MAT 3:

Here I have assumed MAT 3 process is next process step for Bale line 3 , further MAT 3 have 9 machines for a single bale line 3 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart . Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

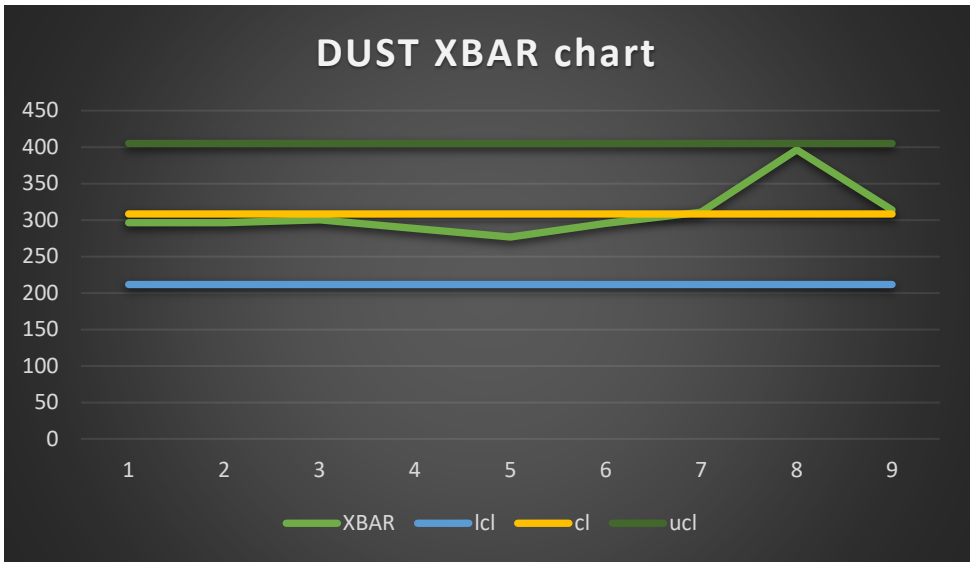
Dust Analysis :

Dataset for Dust Analysis taken for 9 different MAT lines as shown in figure. There is one data that is extremely high in comparison to all that is Mat 3.8 for the date: 2/3/2004 - 2725

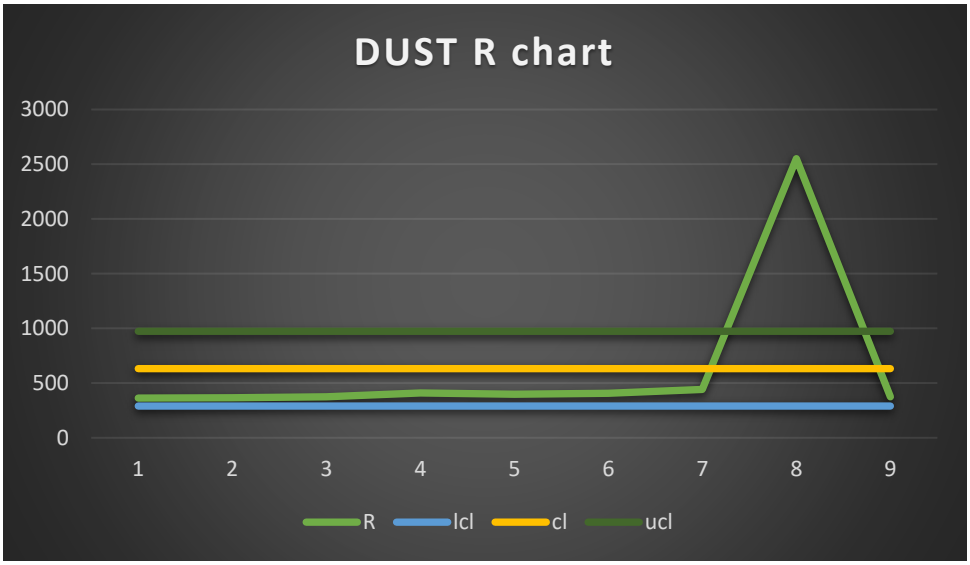
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	XBAR	R	S
388	178	275	179	204	197	193	263	209	230	456	282	223	231	241	337	207	175	227	363	462	445	437	465	538	296.2	363	113.1069
239	194	259	212	197	289	185	195	256	240	489	245	269	205	208	272	201	216	221	331	531	423	482	551	503	296.52	366	121.1848
249	324	256	245	285	243	170	186	203	273	493	242	200	240	217	259	252	227	201	403	403	527	495	372	545	300.4	375	113.2549
205	227	259	179	242	229	211	200	203	243	416	178	276	228	231	207	196	225	179	423	415	449	536	466	589	288.48	411	122.8587
196	203	234	179	203	274	187	239	179	269	441	266	217	138	213	197	215	200	176	360	447	535	501	343	507	276.76	397	118.7397
209	181	245	228	253	411	210	192	170	332	448	272	190	191	212	257	244	269	238	317	339	577	491	368	542	295.44	407	116.3257
208	249	264	224	287	148	194	264	141	257	457	160	198	227	271	303	243	293	231	584	455	580	499	549	485	310.84	443	139.3337
218	2725	197	275	251	221	206	223	227	270	409	288	240	225	174	186	215	307	209	403	423	482	530	465	539	396.32	2551	438.2497
284	305	330	273	213	229	357	203	198	330	459	168	213	246	205	364	239	201	210	380	494	424	543	457	522	313.88	375	114.3811
																								average	308.3156	632	161.9372

	lcl	cl	ucl	lcl	cl	ucl	lcl	cl	ucl
69	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
48	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
49	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
87	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
97	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
57	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
37	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
97	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799
811	211.6196	308.3156	405.0116	290.088	632.00	973.28	91.5917	161.9372	232.3799

The X-Bar chart shows how the mean or average of dust for MAT 3 (1-9 mats for bale line 3). Here we have X-BAR chart for trash which shows everything in MAT 3.1, 3.2, 3.3,3.4,3.5,3.6,3.7,3.8,3.9 is in control with respect to Bale line 3. The Xbar chart is shown below in figure and refer the limits for the chart from figure above. Everything seems to be in control limits but the process is out of control due to a dust content in Mat 3. during 2/3/2004 , as at that time we have dust content of 2725 which is extremely high and makes the process out of control. So assuming at that instant the Mat 3.8 is malfunctioned which makes the process out of control if we eliminate that value then our process is in control. Even I checked back with the bale line 3 for the same date the dust content is in limits that's 639. I can conclude by saying at that instance the Mat 3.8 is malfunctioned.



The R chart (subgroups for less than 9, used to see what happens to the range irrespective of subgroups)) shows the range of random sample over the period taken from all the MAT 2 lines with respect to bale line 3 in the process. The control R chart is shown in the figure.
While analyzing everything over the MAT 3 seems to be in control except for Mat 3.8 and that makes the process out of control for the same reason as it might be malfunctioned at that point of time.



The S chart is used for subgroups more than 9 and I used it to see the variation of standard deviation in all the MAT 3 (1-9 in the mat 2) over bale line 3 over the time period. The chart is also in control

and the trend line is almost similar to the R chart . The S chart is shown below Figure. The process seems to be out of control as it might be malfunctioned at that point of time as discussed above

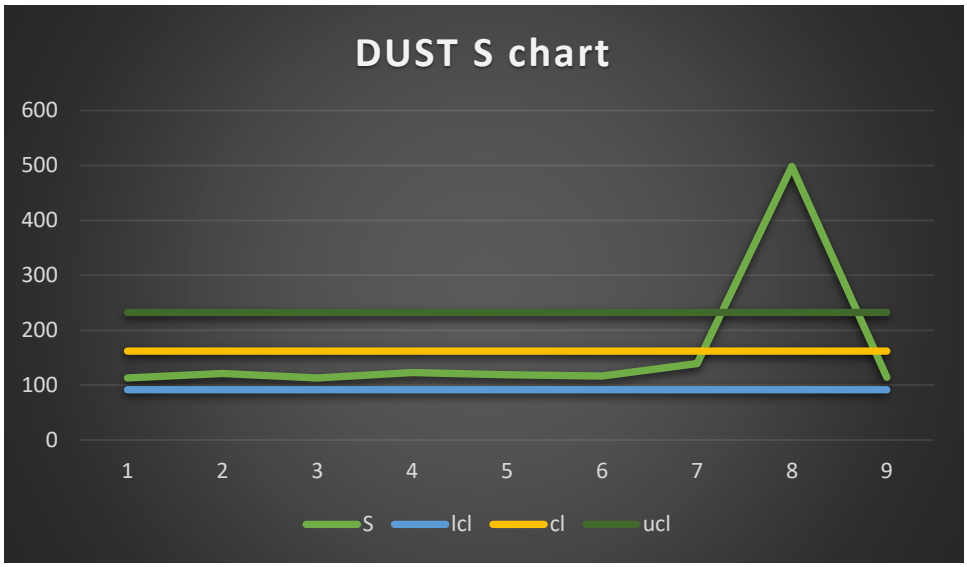


Fig.3.50 Dust S chart

MAT 4:

Here I have assumed MAT 4 process is next process step for Bale line 4 , further MAT 4 have 9 machines for a single bale line 4 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart . Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

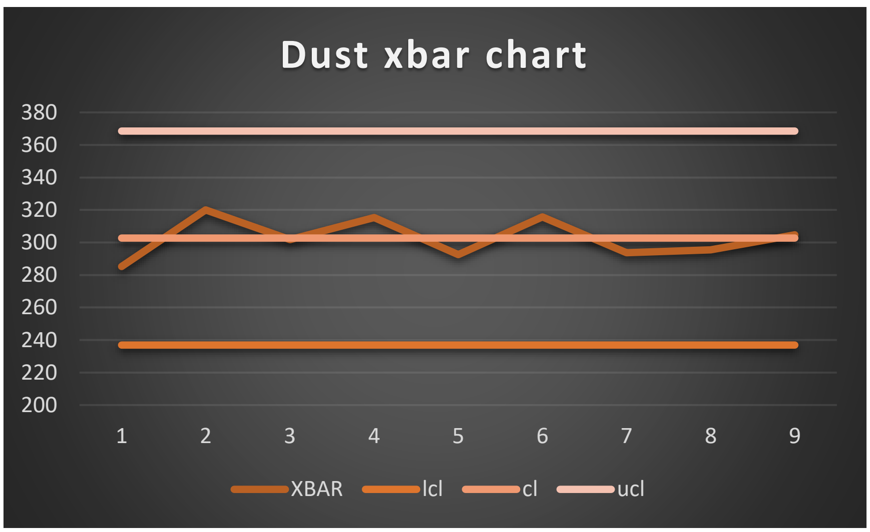
Dust Analysis :

Dataset for Dust Analysis taken for 9 different MAT lines as shown in figure.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	XBAR	R	S	lc
255	313	282	277	371	249	242	205	195	276	343	153	229	118	191	225	243	178	255	419	445	541	434	484	208	285.24	423	108.4094	
266	229	361	452	237	283	259	186	286	269	544	235	225	195	204	263	227	180	265	351	472	485	483	481	563	320.04	383	121.938	
209	339	267	232	272	275	210	262	205	247	368	161	267	309	191	240	249	239	191	331	471	441	441	559	566	301.68	405	112.7001	
221	229	312	305	285	257	213	381	237	247	339	245	187	199	145	223	279	196	180	319	589	383	417	685	809	315.28	664	161.1791	
279	215	325	277	279	251	186	194	219	201	311	185	172	287	221	295	299	176	159	368	447	430	461	503	573	292.52	414	113.1136	
251	328	278	171	274	313	307	263	279	215	297	217	287	236	279	270	293	211	225	521	541	429	421	462	526	315.76	370	105.2086	
284	316	230	184	276	247	233	252	266	167	333	164	261	162	204	233	167	188	179	451	480	529	488	497	553	293.76	391	127.7123	
271	239	272	278	236	223	279	203	219	223	308	201	214	186	167	257	209	183	227	443	571	471	409	469	629	295.48	462	126.9173	
277	323	265	246	247	280	288	185	220	337	379	204	200	273	215	229	215	203	239	392	477	491	404	483	544	304.64	359	105.6586	
																								average	302.7111	430.1111	120.3152	

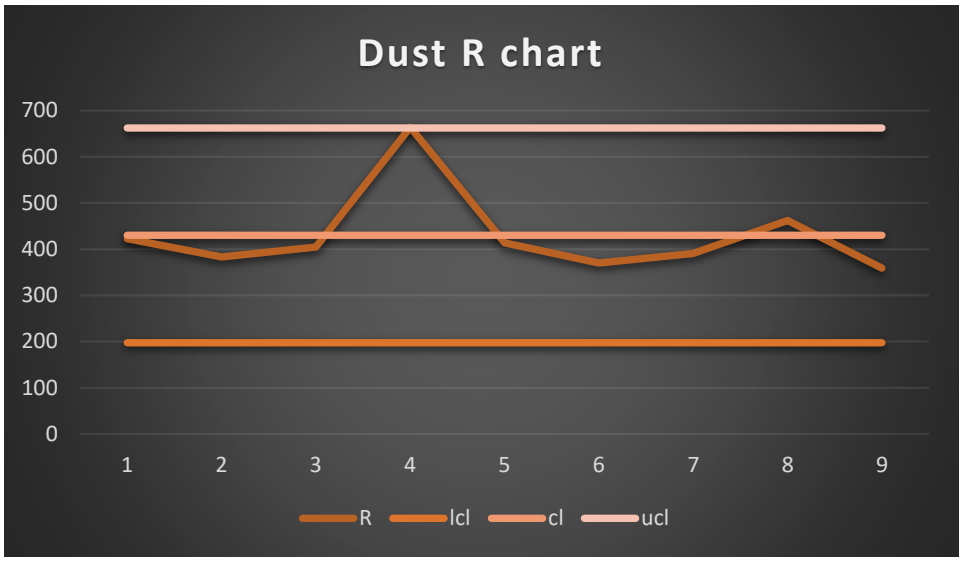
lcl	cl	ucl	lcl	cl	ucl	lcl	cl	ucl
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524
236.9041	302.7111	368.5181	197.421	430.11	662.3711	68.0503	120.3152	172.6524

The X-Bar chart shows how the mean or average of dust for MAT 4 (1-9 mats for bale line 4). Here we have X-BAR chart for trash which shows everything in MAT 4.1, 4.2, 4.3,4.4,4.5,4.6,4.7,4.8,4.9 is in control with respect to Bale line 4. The Xbar chart is shown below in figure and refer the limits for the chart from figure. Everything seems to be in control limits.

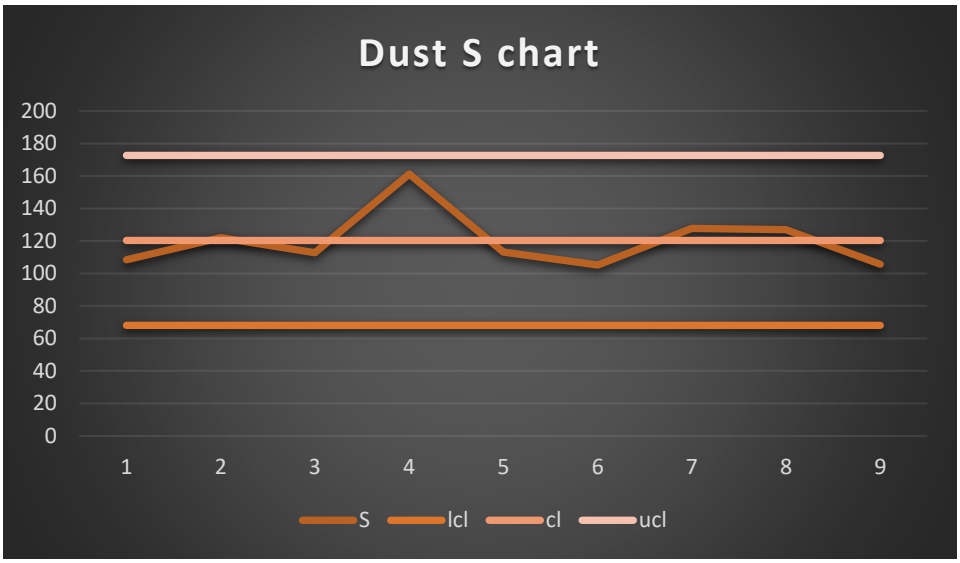


The R chart (subgroups for less than 9, used to see what happens to the range irrespective of subgroups) shows the range of random sample over the period taken from all the MAT 4 lines with respect to bale line 4 in the process. The control R chart is shown in the figure.

While analyzing everything over the MAT 4 seems to be out of control (refer the above for limits) because of Mat 4.4 is equivalent 809 which out of limit on the date 9/26/2005, I checked back with the bale line 4 what's the scenario at that point of time but at that time also the process was in control so it's the sudden increment in dust is due to the machine at that moment might have malfunctioned (heated, something stuck into it or anything else). If I eliminate 809 sample my process is under control.



The S chart is used for subgroups more than 9 and I used it to see the variation of standard deviation in all the MAT 3 (1-9 in the mat 4) over bale line 4 over the time period. The chart is also in control and the trend line is almost similar to the R chart (fig.3.79) . The S chart is shown below Figure. The process seems to be in control.



MAT 5:

Here I have assumed MAT 5 process is next process step for Bale line 5 , further MAT 5 have 9

machines for a single bale line 5 that we are going to analyze. Here we have 9 subgroups still we are considering R chart and S chart . Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

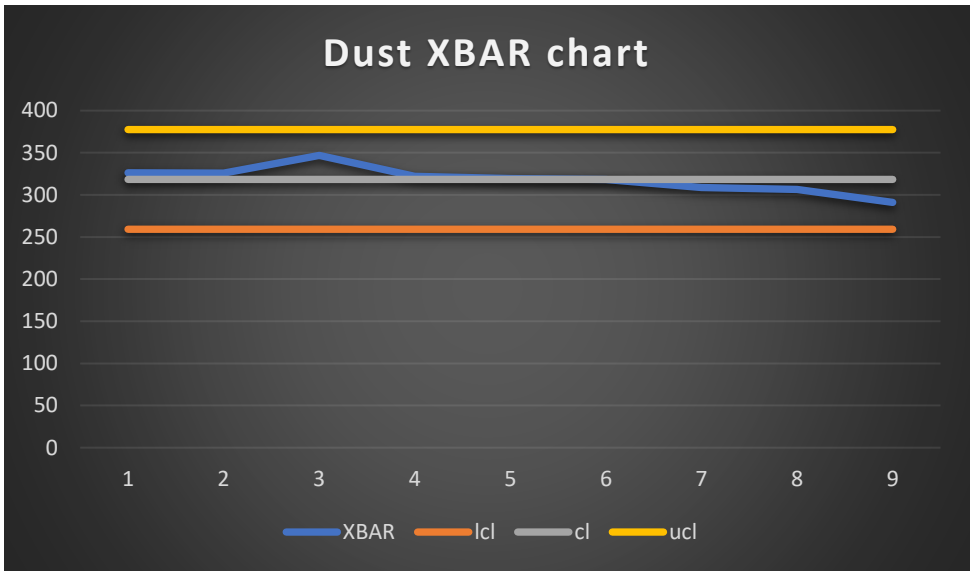
<u>Dust Analysis :</u>

Dataset for Dust Analysis taken for 9 different MAT lines as shown in figure.

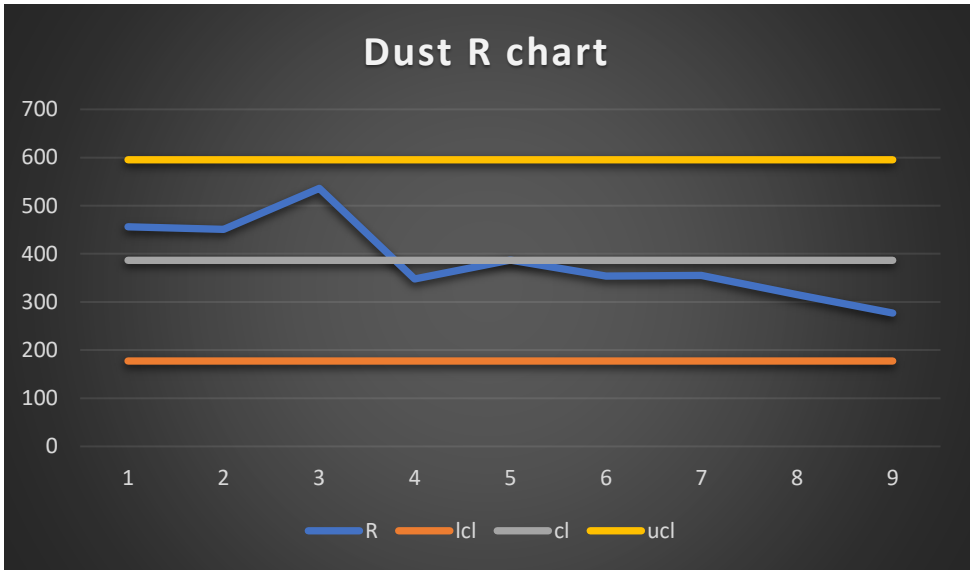
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	XBAR	R	S
319	257	365	260	280	262	227	242	281	351	241	229	229	253	291	272	362	304	237	411	444	501	446	407	683	326.16	456	108.3596
315	261	303	219	237	265	240	259	305	275	295	241	264	239	329	227	458	257	244	466	461	585	369	365	670	325.96	451	116.873
286	307	351	395	389	341	287	223	281	299	701	223	207	302	165	179	445	207	239	480	477	426	388	495	578	346.84	536	131.8752
436	297	325	253	305	256	402	231	315	270	320	202	265	297	211	235	314	267	221	338	445	401	385	510	550	322.04	348	92.38754
299	236	344	291	312	331	281	163	291	341	304	271	269	280	235	186	335	254	168	451	451	491	376	479	550	319.56	387	100.2393
328	175	342	245	321	369	245	250	396	270	336	239	261	223	198	230	346	279	189	410	435	529	317	498	528	318.36	354	102.1653
342	280	367	244	264	269	285	195	294	317	293	156	185	227	383	206	358	231	213	487	357	467	293	511	497	308.84	355	100.3974
309	290	348	279	298	239	289	202	272	217	295	277	235	294	179	158	397	297	282	473	471	371	367	374	451	306.56	315	83.9921
416	250	340	237	296	254	204	223	249	289	326	269	263	285	202	179	285	222	208	349	337	456	304	385	449	291.08	277	76.19379
																								average	318.3778	386.5556	101.387

lcl	cl	ucl	lcl	cl	ucl	lcl	cl	ucl
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904
259.2348	318.3778	377.5208	177.429	386.56	595.2956	57.3445	101.387	145.4904

The X-Bar chart shows how the mean or average of dust for MAT 5 (1-9 mats for bale line 5). Here we have X-BAR chart for trash which shows everything in MAT 5.1, 5.2, 5.3,5.4,5.5,5.6,5.7,5.8,5.9 is in control with respect to Bale line 5. The Xbar chart is shown below in figure and refer the limits for the chart from figure. Everything seems to be in control limits.

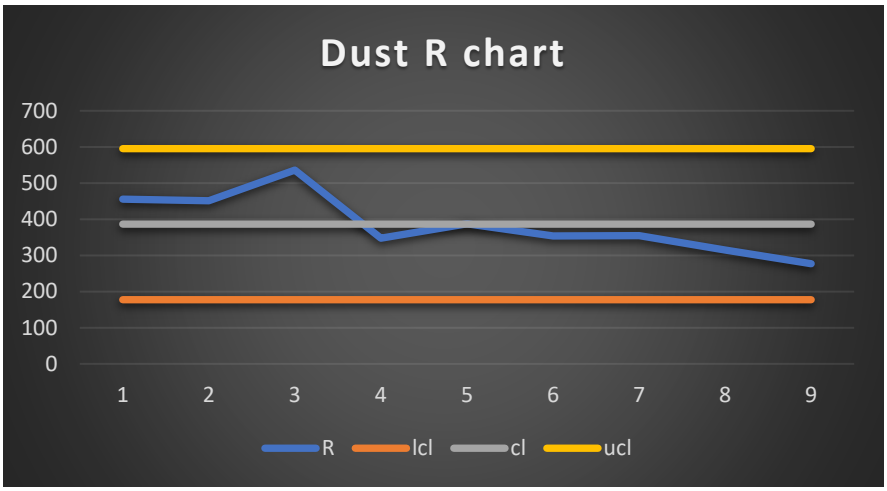


The R chart (subgroups for less than 9, used to see what happens to the range irrespective of subgroups)) shows the range of random sample over the period taken from all the MAT 5 lines with respect to bale line 5 in the process. The control R chart is shown in the figure.



The S chart is used for subgroups more than 9 and I used it to see the variation of standard deviation in all the MAT 5 (1-9 in the mat 4) over bale line 5 over the time period. The chart is also in control and the trend line is almost similar to the R chart . The S chart is shown below figure.The process

seems to be in control.



e X-Bar chart shows how the mean or average of trash for MAT 5 (1-9 mats for bale line 5). Here we have X-BAR chart for trash which shows everything in MAT 5.1, 5.2, 5.3,5.4,5.5,5.6,5.7,5.8,5.9 is in control with respect to Bale line 5. The Xbar chart is shown below in figure and refer the limits for the chart from figure. Everything seems to be in control

MAT 6:

Here I have assumed MAT 6 process is next process step for Bale line 6 , further MAT 6 have 9 machines for a single bale line 6 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart . Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

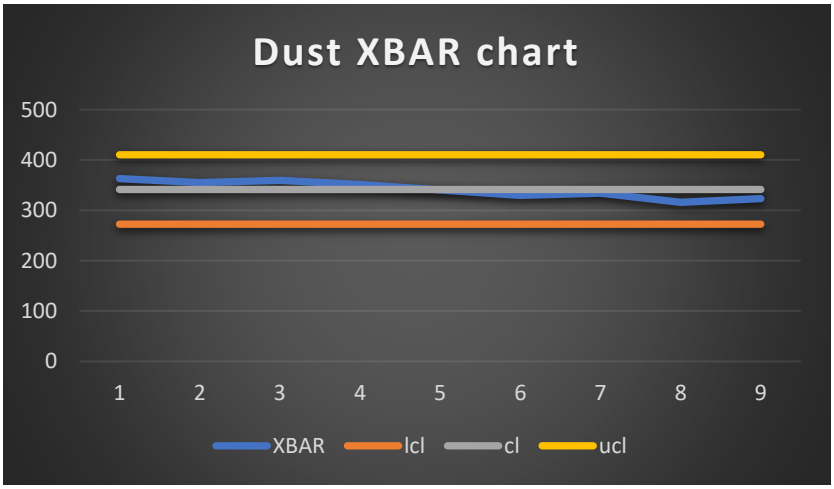
Dust Analysis :

Dataset for Dust Analysis taken for 9 different MAT lines as shown in figure.

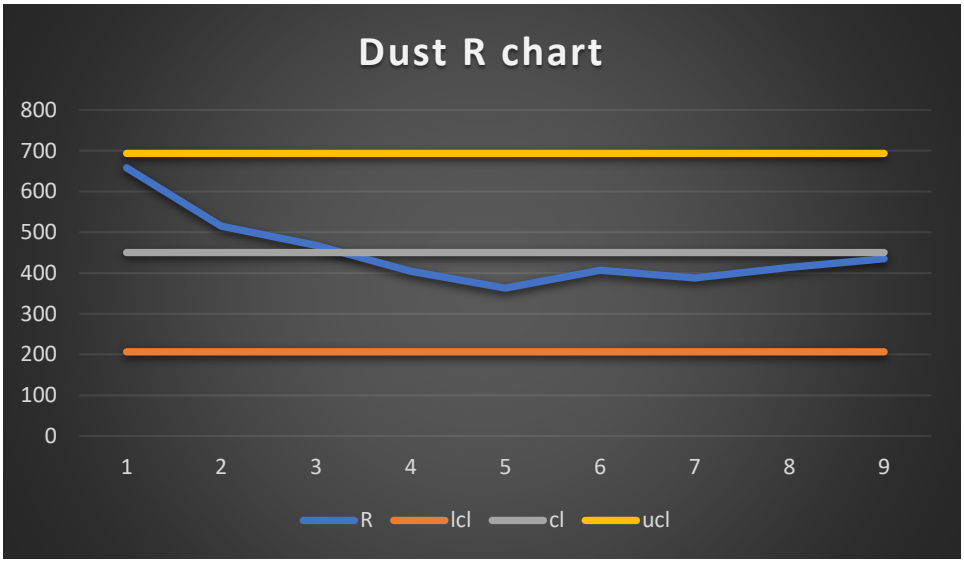
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	XBAR	R	S
334	323	302	307	264	207	311	318	289	281	251	372	496	552	821	405	418	426	244	439	517	209	163	373	453	363	658	138.5174
320	353	336	310	297	225	311	215	269	307	322	357	654	505	556	437	412	467	273	379	435	139	289	383	329	355.2	515	111.2801
304	371	305	321	337	235	257	292	337	281	327	403	603	501	616	398	495	342	352	402	457	148	200	404	287	353.4	468	112.6266
272	345	313	267	332	276	223	324	231	299	266	451	571	469	556	433	403	327	324	334	457	167	211	481	455	351.48	404	108.0081
355	348	238	308	414	281	201	236	219	246	306	369	466	450	518	415	349	409	200	329	563	205	303	360	419	340.28	363	100.4355
275	347	322	232	253	205	281	269	295	302	251	262	462	534	592	478	345	320	229	380	456	187	213	372	305	329.88	407	110.7905
293	279	336	201	253	254	241	350	297	210	327	361	443	523	495	499	427	304	178	354	565	177	217	375	392	334.04	388	110.5978
329	405	226	203	280	268	181	243	285	288	246	364	459	546	480	454	325	343	195	291	399	132	207	413	335	315.88	414	104.6468
253	298	289	256	251	199	262	233	232	273	295	403	481	595	577	361	377	345	216	392	402	160	188	435	314	323.48	435	113.5944
																								average	341.4044	450.2222	112.2775

	lcl	cl	ucl	lcl	cl	ucl	lcl	cl	ucl
4	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
1	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
6	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
1	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
5	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
5	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
8	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
8	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182
4	272.5204	341.4044	410.2884	206.652	450.22	693.3422	63.50413	112.2775	161.1182

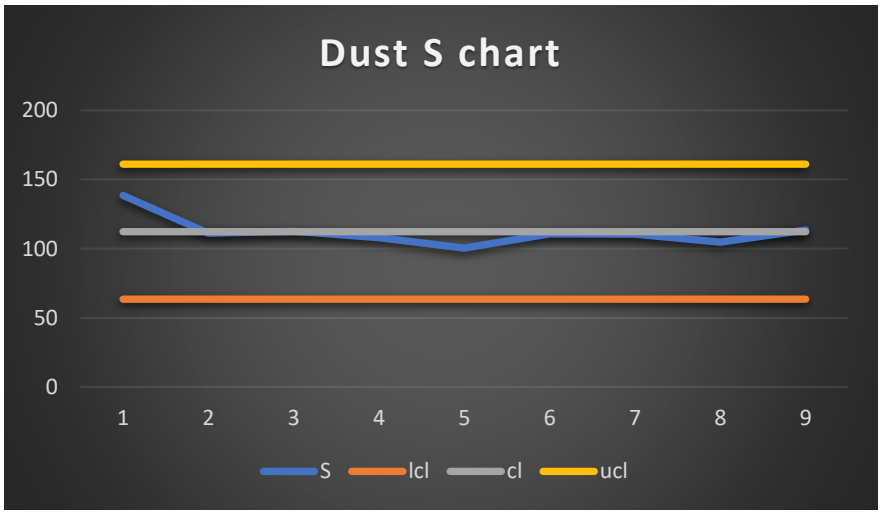
The X-Bar chart shows how the mean or average of dust for MAT 6 (1-9 mats for bale line 6). Here we have X-BAR chart for trash which shows everything in MAT 6.1, 6.2, 6.3,6.4,6.5,6.6,6.7,6.8,6.9 is in control with respect to Bale line 6. The Xbar chart is shown below in fig.3.118 and refer the limits for the chart from fig.3.117. Everything seems to be in control limits.



The R chart (subgroups for less than 9, used to see what happens to the range irrespective of subgroups) shows the range of random sample over the period taken from all the MAT 6 lines with respect to bale line 6 in the process. The control R chart is shown in the figure.



The S chart is used for subgroups more than 9 and I used it to see the variation of standard deviation in all the MAT 6 (1-9 in the mat 6) over bale line 6 over the time period. The S chart is shown below Figure. The process seems to be in control.



Conclusion:

Bale line 1: It is linked with MAT lines 1.1-1.9, While I analysed all the attributes like SFC, Dust, Trash everything seems to be in control even in our quality check 1.

Bale line 2: It is linked with MAT lines 2.1-2.9 , While I analysed all the attributes like SFC, Dust, Trash , I saw that in the Dust parameter MAT 2.9 was out of control the observation was 4967 on

12/06/2004 , further I linked that with the bale line 2 the parameter of dust content was in control so that assures me that there was some issue with the MAT2.9 machine at that instance.
Bale line 3: It is linked with MAT lines 3.1-3.9 . While I analysed all the attributes like SFC, Dust, Trash , I saw that in the Dust parameter MAT 3.8 was out of control the observation was 2725 on 2/03/2004 , further I linked that with the bale line 3 the parameter of dust content was in control so that assures me that there was some issue with the MAT 3.8 machine at that instance. Even I tried to make the process in control by removing it and I was successful and by giving an appropriate reason I can remove that.
Bale line 4: It is linked with MAT lines 4.1-4.9. While I analyzed all the attributes like SFC, Dust, Trash, I saw that in the Dust parameter MAT 4.4 it can be out of control the observation was but as of now it is in control.
Bale line 5: It is linked with MAT lines 5.1-5.9. While I analyzed all the attributes like SFC, Dust, Trash, I saw that every parameter in this case is in control.
Bale line 6: It is linked with MAT lines 6.1-6.9 . While I analyzed all the attributes like SFC, Dust, Trash, seems to be in control even in our quality check 1.

Quality check 3

Third quality check is done after Sliver formation that is before yarn formation on each line separately (SL1.1, SL2.1...). So here we have taken account of Dust, Trash , NEP, SFC%,UQL. We analysed these data according to the SL(1-6) and assuming some factors. We used R, S and Xbar control charts and calculated Cp. We used these charts as other charts required some additional information and our data were not satisfying the need in the terms of subgroups and some other factor of the charts to obtain a desired output to analyse the data and comment over the process
Assumptions:

1. Assuming for bale line 1 there is SL1.1, SLt1.2….SL1.9
2. Also assuming the process is going with the similar dates with the bale lines
3. The value for the constants used for the charts are A2=0.153, D3=0.459, D4=1.54, B3=0.5656 and B4=1.435.

SL 1:
Here I have assumed SL 1 process is next process step for Bale line 1 , after MAT , here 1 have 9 machines for a single bale line 1 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.
We concluded by looking at the graphs everything is in control with respect to bale line 1 and Mat machines.Dust Analysis :
The X-Bar chart shows how the mean or average of dust for SL 1 (1-9 SL for bale line 1). Here we have X-BAR chart for dust which shows everything in SL 1.1, 1.2, 1.3,1.4,1.5,1.6,1.7,1.8,1.9 is in control with respect to Bale line 1 and MAT line 1. Except for the Sliver 6.

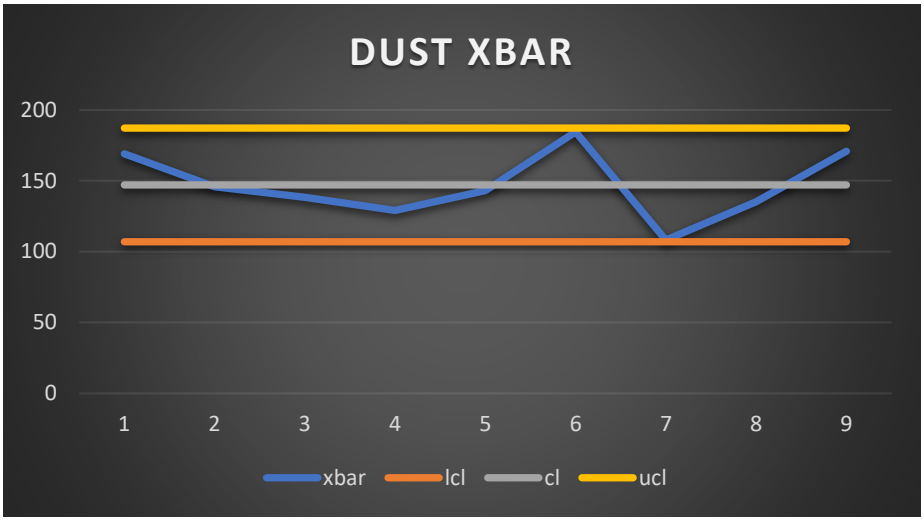


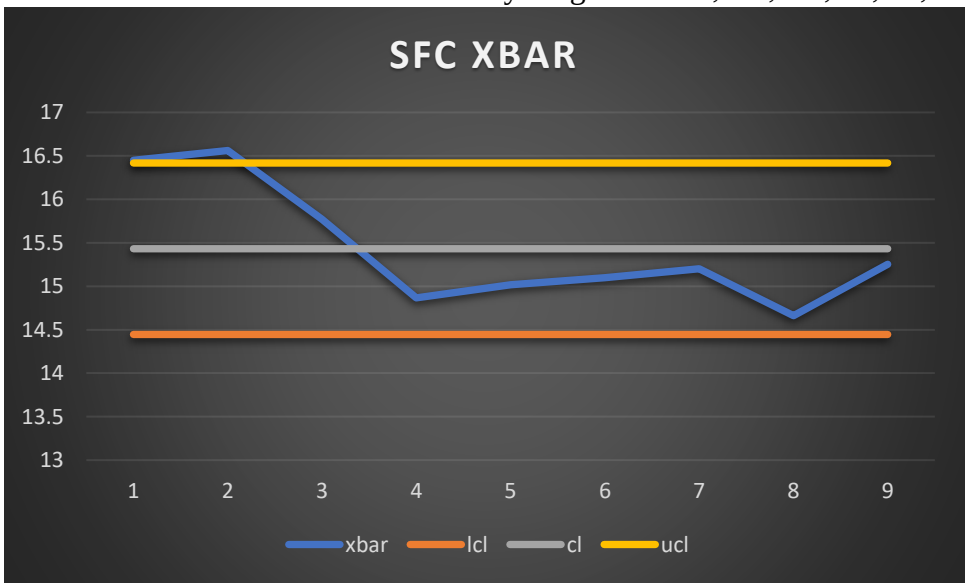
Fig.3.98 Dust Xbar chart

SL 2:

Here I have assumed SL 2 process is next process step for Bale line 2, after MAT , here 2 have 9 machines for a single bale line 2 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

SFC Analysis :

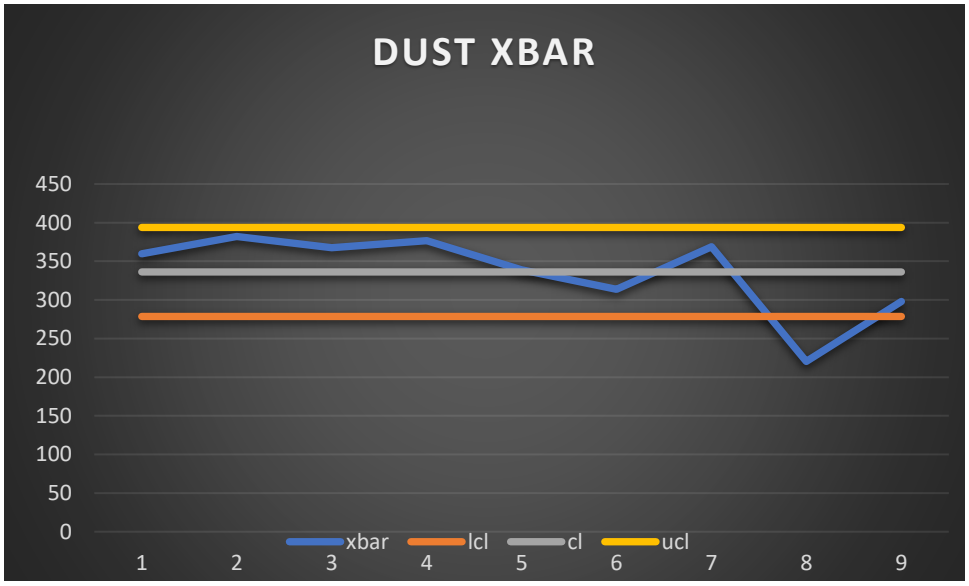
The X-Bar chart shows how the mean or average of dust for SL 2 (1-9 SL for bale line 2). Here we have X-BAR chart for SFC which shows everything in SL 2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.8,2.9

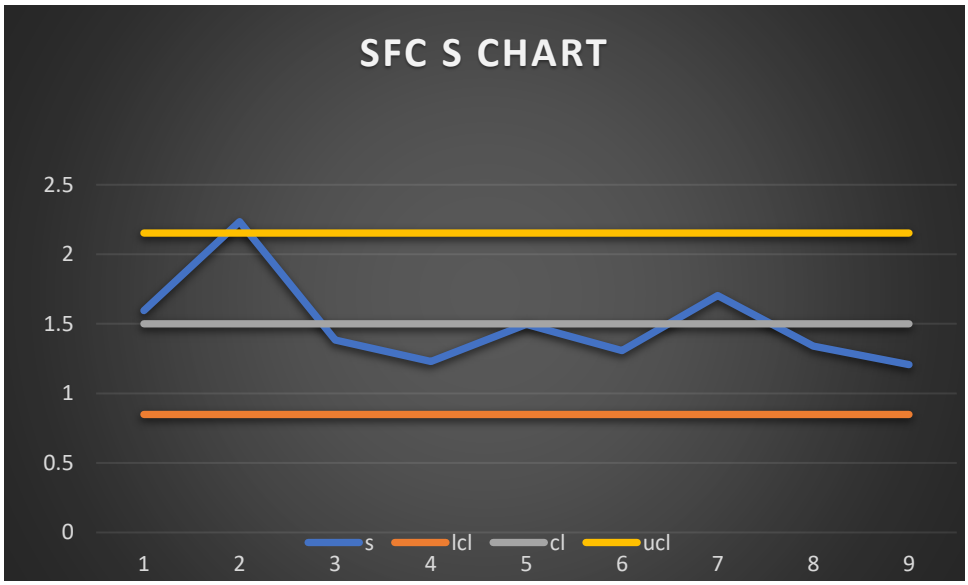


is in control with respect to Bale line 2 and MAT line 2. Except for the Sliver 2, which makes the process out of control because of the observation 25.2 the 12 th observation in SL 2.2 that we can evaluate from XBAR and S chart.

Dust Analysis :

The X-Bar chart shows how the mean or average of dust for SL 2 (1-9 SL for bale line 2). Here we have X-BAR chart for Dust which shows everything in SL 2.1, 2.2, 2.3,2.4,2.5,2.6,2.7,2.8,2.9 Infact Bale line 2 and for the Sliver 2.8, which makes the process out of control we can evaluate from XBAR CHART.





SL 3:

Here I have assumed SL 3 process is next process step for Bale line 3, after MAT , here WE have 9 machines for a single bale line 3 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

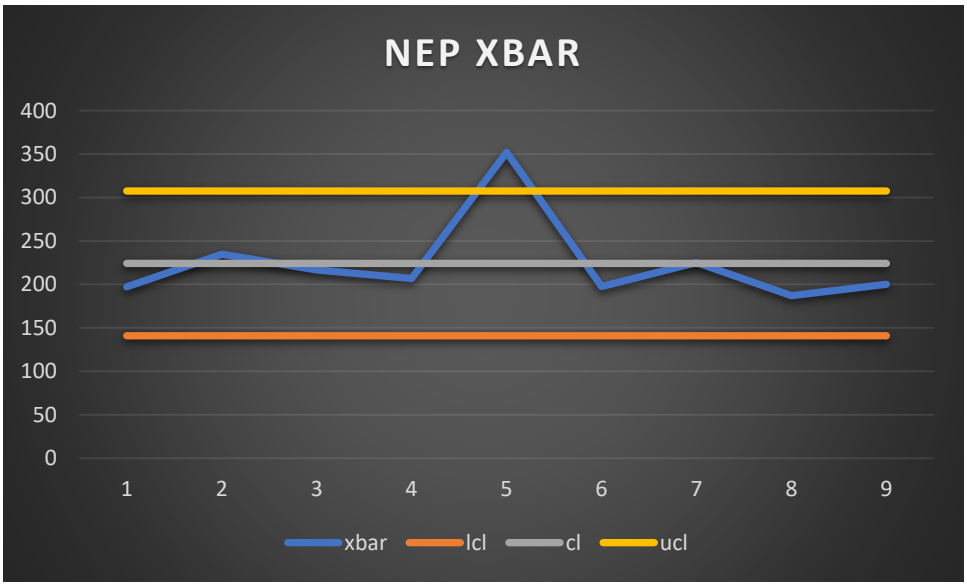
Well after analyzing all the control charts for all the parameter I can comment that all the process for SL 3 is in control except for the dust parameter for Sliver 3.7 that is almost at the verge of going beyond the lower limit but is still in control.

SL 4:

Here I have assumed SL 4 process is next process step for Bale line 4, after MAT , here we have 9 machines for a single bale line 4 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

NEP Analysis:

In this I can see that SL 4.5 as from 1-15 samples there is no observation recorded. This is an error due to the power cut off or maybe there was power outage due to some reasons.

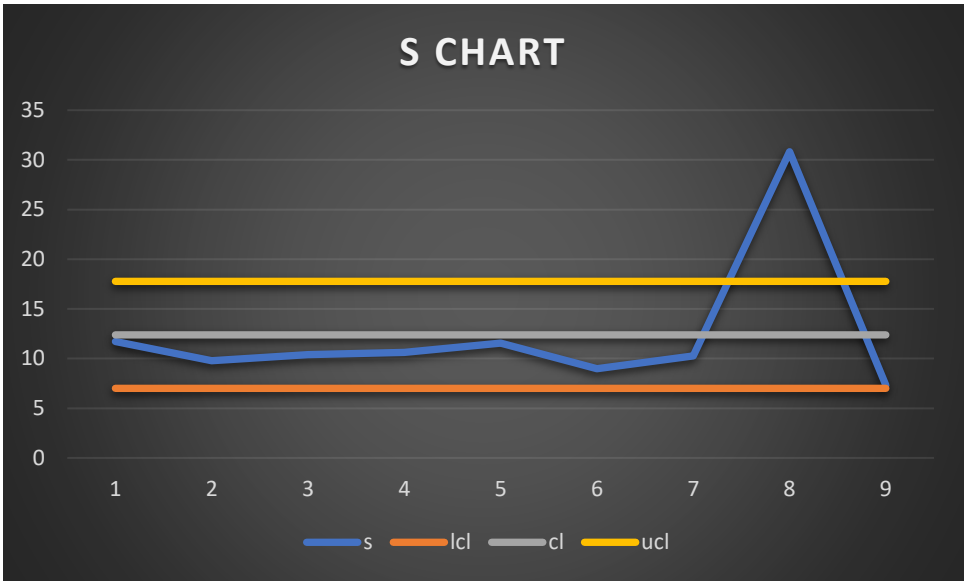


SL 5:

Here I have assumed SL 5 process is next process step for Bale line 5, after MAT , here we have 9 machines for a single bale line 5 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

Trash Analysis:

Here the SL 5.8 is going out of control which makes the whole process out of control for which



the observation is approx. 175 which is extremely high as at this point the trash content should be low, consulting the previous process that we analysed everything was in control except for the particular instance this means there might be malfunction in between effectively on that day that is 03/24/2004.

SL 6:

Here I have assumed SL 6 process is next process step for Bale line 6, after MAT , here we have 9 machines for a single bale line 6 that we are going to analyse. Here we have 9 subgroups still we are considering R chart and S chart. Most preferred chart here will me S chart as it is considered for subgroups equivalent to 9.

Everything is in control but there are few observations for the parameters that can make the process out of control rather are on the verge of going out of control.

CONCLUSION

I can conclude by saying this Bale line 1, Bale line 5, Bale line 6 are most appropriate and the the process is in control apart from the Bale line 2 , Bale line 3 and Bale line 4 are out of control which we have talked about and given reasons to justify why the process is out of control, we used various types of control charts and analyzed why did we use those charts and justified them. Further refer to the excel sheet for more detailed explanation.