Effect of Parameters on the Cost of Memory Type Chart

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CONTENTS

Introduction

- The control chart was developed by Shewhart in 1924 and it is useful for monitoring and detecting process mean shifts.
- Since then, control charts are used in industries for process monitoring and improvement.

Introduction

- The Shewhart chart is effective for detecting large process mean shifts.
- It is insensitive towards small and moderate shifts.
- The memory-type control chart, i.e. EWMA chart was introduced to enhance the sensitivity of the Shewhart chart.

Introduction

- The cost of implementing the control chart will influence the decision on the choice of a control chart.
- Impact of the input parameters on the expected cost of implementing the EWMA control chart will be studied.

Objectives

1. To propose the sensitivity analysis of the EWMA control chart.
2. To investigate the impact of the input parameters on the expected cost of implementing the EWMA control chart.

Exponentially Weighted Moving Average (EWMA) Chart

- The EWMA statistic is given as

$$Z_u = \lambda Y_u + (1-\lambda) Z_{u-1}, \text{ for } u = 1, 2, \ldots,$$

where λ is a smoothing constant with $0 < \lambda \leq 1$ and Y_u is

$$Y_u = \frac{\bar{X}_u - \mu_0}{\sigma_0 / \sqrt{n}}.$$

- μ_0 and σ_0 are the in-control process mean and in-control process standard deviation, respectively, and are assumed known.
- $\bar{X}_u$ is the mean of the u^{th} sample and n is the sample size.

Exponentially Weighted Moving Average (EWMA) Chart

- The lower control limit (LCL) and upper control limit (UCL) of the EWMA chart are defined as

$$\text{LCL} = -J\sqrt{\frac{\lambda}{2-\lambda}}$$

and

$$\text{UCL} = J\sqrt{\frac{\lambda}{2-\lambda}}$$

with $J > 0$ is the width constant.

- An out-of-control is issued when a point plots above the UCL or below the LCL.
- Commonly used to detect small shifts in the process.

Economic Model of the EWMA Chart

- The optimal charting parameters are obtained based on minimizing the expected cost function.
- The implementing cost of the EWMA control chart is calculated based on the cost function.

Sensitivity Analysis of the EWMA Chart

- It is crucial to identify the input parameter that has an impact on the cost of implementing the EWMA chart.
- 14 input parameters have been identified.

Table 1: Different combinations of the input parameters.

No.	θ	δ	C_0(\$)	C_1(\$)	Y(\$)	W(\$)	b(\$)	c(\$)	e	T_0	T_1	T_2	γ_1	γ_2
1	**0.01**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
2	**0.02**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
3	**0.04**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
4	0.02	**0.43**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
5	0.02	**0.86**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
6	0.02	**1.72**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
7	0.02	0.86	**57.12**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
8	0.02	0.86	**114.24**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
9	0.02	0.86	**228.48**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
10	0.02	0.86	114.24	**474.6**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
11	0.02	0.86	114.24	**949.2**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
12	0.02	0.86	114.24	**1898.4**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
13	0.02	0.86	114.24	949.2	**488.7**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
14	0.02	0.86	114.24	949.2	**977.4**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
15	0.02	0.86	114.24	949.2	**1954.8**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
16	0.02	0.86	114.24	949.2	977.4	**488.7**	0	4.22	0.083	0.083	0.083	0.75	1	0
17	0.02	0.86	114.24	949.2	977.4	**977.4**	0	4.22	0.083	0.083	0.083	0.75	1	0
18	0.02	0.86	114.24	949.2	977.4	**1954.8**	0	4.22	0.083	0.083	0.083	0.75	1	0
19	0.02	0.86	114.24	949.2	977.4	977.4	**0**	4.22	0.083	0.083	0.083	0.75	1	0
20	0.02	0.86	114.24	949.2	977.4	977.4	**5**	4.22	0.083	0.083	0.083	0.75	1	0
21	0.02	0.86	114.24	949.2	977.4	977.4	**10**	4.22	0.083	0.083	0.083	0.75	1	0
22	0.02	0.86	114.24	949.2	977.4	977.4	0	**2.11**	0.083	0.083	0.083	0.75	1	0
23	0.02	0.86	114.24	949.2	977.4	977.4	0	**4.22**	0.083	0.083	0.083	0.75	1	0
24	0.02	0.86	114.24	949.2	977.4	977.4	0	**8.44**	0.083	0.083	0.083	0.75	1	0
25	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.0415**	0.083	0.083	0.75	1	0
26	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.083**	0.083	0.083	0.75	1	0
27	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.166**	0.083	0.083	0.75	1	0
28	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.0415**	0.083	0.75	1	0
29	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.083**	0.083	0.75	1	0
30	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.166**	0.083	0.75	1	0
31	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.0415**	0.75	1	0
32	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.083**	0.75	1	0
33	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.166**	0.75	1	0
34	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**0.375**	1	0
35	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**0.75**	1	0
36	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**1.50**	1	0
37	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**0**	**0**
38	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**1**	**0**
39	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**0**	**1**
40	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**1**	**1**

Table 1: Different combinations of the input parameters.

No.	θ	δ	C_0($)	C_1($)	Y($)	W($)	b($)	c($)	e	T_0	T_1	T_2	γ_1	γ_2
1	**0.01**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
2	**0.02**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
3	**0.04**	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
4	0.02	**0.43**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
5	0.02	**0.86**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
6	0.02	**1.72**	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
7	0.02	0.86	**57.12**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
8	0.02	0.86	**114.24**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
9	0.02	0.86	**228.48**	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
10	0.02	0.86	114.24	**474.6**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
11	0.02	0.86	114.24	**949.2**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
12	0.02	0.86	114.24	**1898.4**	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
13	0.02	0.86	114.24	949.2	**488.7**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
14	0.02	0.86	114.24	949.2	**977.4**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
15	0.02	0.86	114.24	949.2	**1954.8**	977.4	0	4.22	0.083	0.083	0.083	0.75	1	0
16	0.02	0.86	114.24	949.2	977.4	**488.7**	0	4.22	0.083	0.083	0.083	0.75	1	0
17	0.02	0.86	114.24	949.2	977.4	**977.4**	0	4.22	0.083	0.083	0.083	0.75	1	0
18	0.02	0.86	114.24	949.2	977.4	**1954.8**	0	4.22	0.083	0.083	0.083	0.75	1	0
19	0.02	0.86	114.24	949.2	977.4	977.4	**0**	4.22	0.083	0.083	0.083	0.75	1	0
20	0.02	0.86	114.24	949.2	977.4	977.4	**5**	4.22	0.083	0.083	0.083	0.75	1	0
21	0.02	0.86	114.24	949.2	977.4	977.4	**10**	4.22	0.083	0.083	0.083	0.75	1	0
22	0.02	0.86	114.24	949.2	977.4	977.4	0	**2.11**	0.083	0.083	0.083	0.75	1	0
23	0.02	0.86	114.24	949.2	977.4	977.4	0	**4.22**	0.083	0.083	0.083	0.75	1	0
24	0.02	0.86	114.24	949.2	977.4	977.4	0	**8.44**	0.083	0.083	0.083	0.75	1	0
25	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.0415**	0.083	0.083	0.75	1	0
26	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.083**	0.083	0.083	0.75	1	0
27	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	**0.166**	0.083	0.083	0.75	1	0
28	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.0415**	0.083	0.75	1	0
29	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.083**	0.083	0.75	1	0
30	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	**0.166**	0.083	0.75	1	0
31	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.0415**	0.75	1	0
32	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.083**	0.75	1	0
33	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	**0.166**	0.75	1	0
34	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**0.375**	1	0
35	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**0.75**	1	0
36	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	**1.50**	1	0
37	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**0**	**0**
38	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**1**	**0**
39	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**0**	**1**
40	0.02	0.86	114.24	949.2	977.4	977.4	0	4.22	0.083	0.083	0.083	0.75	**1**	**1**

- It can be performed on a one factor at a time basis.
- One of the input parameters is modified each time, while the other 13 input parameters remain unchanged.

Table 2: Optimal cost of the EWMA control chart.

No.	Cost	Percentage difference from optimal cost, %
1	187.91	-15.5
2	222.37	0.0
3	273.66	23.1
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
7	194.60	-12.5
8	222.37	0.0
9	327.97	47.5
10	188.49	-15.2
11	222.37	0.0
12	269.11	21.0
13	215.28	-3.2
14	222.37	0.0
15	229.03	3.0
16	213.31	-4.1
17	222.37	0.0
18	240.47	8.1
19	222.37	0.0
20	238.22	7.1
21	250.04	12.4
22	202.44	-9.0
23	222.37	0.0
24	246.67	10.9
25	221.20	-0.5
26	222.37	0.0
27	224.69	1.0
28	222.37	0.0
29	222.37	0.0
30	222.37	0.0
31	221.78	-0.3
32	222.37	0.0
33	223.53	0.5
34	223.92	0.7
35	222.37	0.0
36	219.32	-1.4
37	220.67	-0.8
38	222.37	0.0
39	234.29	5.4
40	236.00	6.1

No.	C_0($)	C_1($)	c($)
7	**57.12**	949.2	4.22
8	**114.24**	949.2	4.22
9	**228.48**	949.2	4.22
10	114.24	**474.6**	4.22
11	114.24	**949.2**	4.22
12	114.24	**1898.4**	4.22
22	114.24	949.2	**2.11**
23	114.24	949.2	**4.22**
24	114.24	949.2	**8.44**

No.	Cost	Percentage difference from optimal cost, %
7	194.60	-12.5
8	222.37	0.0
9	327.97	47.5
10	188.49	-15.2
11	222.37	0.0
12	269.11	21.0
22	202.44	-9.0
23	222.37	0.0
24	246.67	10.9

• The implementation cost of the EWMA control chart increases when the expected quality cost per unit time while the process is in-control, C_0, expected quality cost per unit time while the process is out-of-control, C_1 and cost per unit sampled, c increase, and vice versa.

No.	C_0($)	C_1($)	c($)
7	**57.12**	949.2	4.22
8	**114.24**	949.2	4.22
9	**228.48**	949.2	4.22
10	114.24	**474.6**	4.22
11	114.24	**949.2**	4.22
12	114.24	**1898.4**	4.22
22	114.24	949.2	**2.11**
23	114.24	949.2	**4.22**
24	114.24	949.2	**8.44**

No.	Cost	Percentage difference from optimal cost, %
7	194.60	-12.5
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11	222.37	0.0
12	269.11	21.0
22	202.44	-9.0
23	222.37	0.0
24	246.67	10.9

- The implementation cost of the EWMA control chart increases when the expected quality cost per unit time while the process is in-control, C_0, expected quality cost per unit time while the process is out-of-control, C_1 and cost per unit sampled, c increase, and vice versa.
- C_0 has a greater effect on expected cost.
- When C_0 increases, expected cost increases by 47.5%.

No.	Y($)	W($)	b($)
13	**488.7**	977.4	0
14	**977.4**	977.4	0
15	**1954.8**	977.4	0
16	977.4	**488.7**	0
17	977.4	**977.4**	0
18	977.4	**1954.8**	0
19	977.4	977.4	**0**
20	977.4	977.4	**5**
21	977.4	977.4	**10**

No.	Cost	Percentage difference from optimal cost, %
13	215.28	-3.2
14	222.37	0.0
15	229.03	3.0
16	213.31	-4.1
17	222.37	0.0
18	240.47	8.1
19	222.37	0.0
20	238.22	7.1
21	250.04	12.4

- The input parameters Y and W have a minor effect on the expected cost.
- The increase in the value of Y and W increased the expected cost by 3% and 8.1%, respectively.

No.	Y($)	W($)	b($)
13	**488.7**	977.4	0
14	**977.4**	977.4	0
15	**1954.8**	977.4	0
16	977.4	**488.7**	0
17	977.4	**977.4**	0
18	977.4	**1954.8**	0
19	977.4	977.4	**0**
20	977.4	977.4	**5**
21	977.4	977.4	**10**

No.	Cost	Percentage difference from optimal cost, %
13	215.28	-3.2
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16	213.31	-4.1
17	222.37	0.0
18	240.47	8.1
19	222.37	0.0
20	238.22	7.1
21	250.04	12.4

- The input parameters Y and W have a minor effect on the expected cost.
- The increase in the value of Y and W increased the expected cost by 3% and 8.1%, respectively.
- The expected cost increased when the fixed cost per sample, b, increased.

No.	e	T_0	T_1
25	**0.0415**	0.083	0.083
26	**0.083**	0.083	0.083
27	**0.166**	0.083	0.083
28	0.083	**0.0415**	0.083
29	0.083	**0.083**	0.083
30	0.083	**0.166**	0.083
31	0.083	0.083	**0.0415**
32	0.083	0.083	**0.083**
33	0.083	0.083	**0.166**

No.	Cost	Percentage difference from optimal cost, %
25	221.20	-0.5
26	222.37	0.0
27	224.69	1.0
28	222.37	0.0
29	222.37	0.0
30	222.37	0.0
31	221.78	-0.3
32	222.37	0.0
33	223.53	0.5

- The expected cost remains the same for the input parameter expected time to search a false alarm, T_0.

No.	e	T_0	T_1
25	**0.0415**	0.083	0.083
26	**0.083**	0.083	0.083
27	**0.166**	0.083	0.083
28	0.083	**0.0415**	0.083
29	0.083	**0.083**	0.083
30	0.083	**0.166**	0.083
31	0.083	0.083	**0.0415**
32	0.083	0.083	**0.083**
33	0.083	0.083	**0.166**

No.	Cost	Percentage difference from optimal cost, %
25	221.20	-0.5
26	222.37	0.0
27	224.69	1.0
28	222.37	0.0
29	222.37	0.0
30	222.37	0.0
31	221.78	-0.3
32	222.37	0.0
33	223.53	0.5

- The expected cost remains the same for the input parameter expected time to search a false alarm, T_0.
- The expected time to sample and interpret one unit, e and the expected time to determine the assignable cause, T_1, have a small impact on the expected cost.

No.	θ	T_2
1	**0.01**	0.75
2	**0.02**	0.75
3	**0.04**	0.75
34	0.02	**0.375**
35	0.02	**0.75**
36	0.02	**1.50**

No.	Cost	Percentage difference from optimal cost, %
1	187.91	-15.5
2	222.37	0.0
3	273.66	23.1
34	223.92	0.7
35	222.37	0.0
36	219.32	-1.4

• The expected cost decreases by 1.4% when the expected time to repair the process, T_2, increases from 0.75 to 1.50.

No.	θ	T_2
1	**0.01**	0.75
2	**0.02**	0.75
3	**0.04**	0.75
34	0.02	**0.375**
35	0.02	**0.75**
36	0.02	**1.50**

No.	Cost	Percentage difference from optimal cost, %
1	187.91	-15.5
2	222.37	0.0
3	273.66	23.1
34	223.92	0.7
35	222.37	0.0
36	219.32	-1.4

- The expected cost decreases by 1.4% when the expected time to repair the process, T_2, increases from 0.75 to 1.50.
- The cost decreases when the process failure rate, θ decreases and vice versa.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
37	220.67	-0.8
38	222.37	0.0
39	234.29	5.4
40	236.00	6.1

- When the process shift, δ, increases by 50% from 0.86 to 1.72, the cost reduced by 16.6%.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
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38	222.37	0.0
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40	236.00	6.1

- When the process shift, δ, increases by 50% from 0.86 to 1.72, the cost reduced by 16.6%.
- As the size of process shift decreases, the cost increased by 25.3% from 222.37 to 278.56.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
37	220.67	-0.8
38	222.37	0.0
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- As the size of process shift decreases, the cost increased by 25.3% from 222.37 to 278.56.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

γ_1 = 1 if production continues during search
= 0 if production stops during search

γ_2 = 1 if production continues during repair
= 0 if production stops during repair

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
37	220.67	-0.8
38	222.37	0.0
39	234.29	5.4
40	236.00	6.1

• The production status during search, γ_1, and production status during repair, γ_2, show that when production stops during search and repair, the optimal cost decreased from 222.37 to 220.67.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

γ_1 = 1 if production continues during search
= 0 if production stops during search

γ_2 = 1 if production continues during repair
= 0 if production stops during repair

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
37	220.67	-0.8
38	222.37	0.0
39	234.29	5.4
40	236.00	6.1

- The production status during search, γ_1, and production status during repair, γ_2, show that when production stops during search and repair, the optimal cost decreased from 222.37 to 220.67.
- The optimal cost increases by 6.1% when the production continues during search and repair.

No.	δ	γ_1	γ_2
4	**0.43**	1	0
5	**0.86**	1	0
6	**1.72**	1	0
37	0.86	**0**	**0**
38	0.86	**1**	**0**
39	0.86	**0**	**1**
40	0.86	**1**	**1**

γ_1 = 1 if production continues during search
= 0 if production stops during search

γ_2 = 1 if production continues during repair
= 0 if production stops during repair

No.	Cost	Percentage difference from optimal cost, %
4	278.56	25.3
5	222.37	0.0
6	185.48	-16.6
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38	222.37	0.0
39	234.29	5.4
40	236.00	6.1

- The production status during search, γ_1, and production status during repair, γ_2, show that when production stops during search and repair, the optimal cost decreased from 222.37 to 220.67.
- The optimal cost increases by 6.1% when the production continues during search and repairs.
- The same phenomenon occurs when the production stops during search and production continues during repair, i.e. increased by 5.4%.

Conclusion

- The sensitivity analysis was carried out by increasing and decreasing the values of the input parameters by 50%.
- 13 input parameters influence the cost parameter.
- The effect of each input parameter on the cost is different.
- The cost of implementing the EWMA control chart is increased by 47.5% when the expected quality cost per unit time while the process is in-control, C_0 is increased by 50%.
- This research provides an overview of the influence of the input parameters on the cost of implementing the EWMA control chart.

THANK YOU

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