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Determination of the Stability of a Potable Water Production Line Using Lean Six Sigma Method: A Case Study of XYZ Water Factory

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Abstract

The research, being a case study, aims to determine the stability of the potable water production line of XYZ water factory, for possible improvement, using tools from the lean six sigma (LSS) methodology. This research was carried out on the mean weekly laboratory results of physicochemical water parameters (pH, conductivity, turbidity, alkalinity, chloride, total dissolved solids (TDS), magnesium, nitrates, sulphate, hardness, calcium, lead, copper, iron, and zinc) for regulatory purpose. The data obtained were analysed using control charts from the minitab 2021 ® statistical software package. The values of the parameters (except iron) in the control charts were beyond the conventional limits at various points in time throughout the period. The research results showed that the water production process is not stable, indicative of assignable causes of variability in the production line for all the parameters. Therefore, there is need to carry out investigations to know the causes and take action to correct them. This could be achieved by deploying the appropriate tools in the lean six sigma (DMAIC) methodology.

Keywords: Process stability, lean six sigma, continuous improvement, control charts, assignable causes.

1.0 INTRODUCTION

In the world today, quality is a competitive weapon which organisations use to attract customers in the global market place [1-2]. This is done to ensure customer's satisfaction and for the sustainability which could be achieved by the continuous improvement in the business processes to be more effective and efficient, as is the case of Toyota [3]**.** Continuous improvement as a means of reduction in variability in process and product, is the key goal of quality and the key parameter for organizational success [4].

Different conceptions, methods, and tools may be employed to uphold the good quality level and help in continuous improvement in an organisation [5]. Two of such methods, which were later integrated into one, are lean and six sigma [6]. Lean production (also called lean manufacturing, lean management or just lean) is a managerial framework used for organizational improvement, focused on waste elimination and cost reduction [7]. The term refers to the production system created by the Toyota Motor Corporation to deliver products of right quality, in right quantity, at the right price, to meet the customer's needs [8]. Lean emphases on producing products and services at minimum time and cost [9]. On the other hand, six sigma as a technique originated during the quality evolution in Japan and Motorola, intended to sustain final product quality by focusing on obtaining significantly higher conformance levels [10]. It is a data driven methodology, which uses statistical analysis to detect root-causes of problems and evaluate process performance with its own unit known as the Sigma unit [11].

Individually, Lean increases the efficiency of systems, whereas, Six Sigma increases the efficiency of processes [6]. Hence, Lean and Six Sigma are unable to reach the improvement rates their integration as Lean Six Sigma (LSS) is achieving [12].

Lean Six Sigma refers to the integration of Lean and Six Sigma business improvement methodologies [13], which creates an opportunity to improve the products, satisfying the customers' needs and requirements and growing profits and guides the management to handle the defect reducing defects ratio [14]. According to [10], within the framework of Lean, the objective is to eliminate waste throughout a manufacturing system whereas Six Sigma, concentrates on reducing defects in a process, hence, serve complementary purpose, as both bodies of knowledge are needed to effectively solve problems encountered by an organization. Whereas, [15], stated that

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the application of Lean Six Sigma (LSS) for implementing quality improvement has thrived so much in the 21st century, and the effective method for business and industry, [16], also affirmed that, it has been proven and applied in many manufacturing floors. [15], inferred that, because the methodology is adaptable, researchers encourage trial applications in new fields, which can lead to success if applied carefully.

According to [17], Lean Six Sigma (LSS) has the same DMAIC improvement process as the original Six Sigma, but in addition to Six Sigma tools, Lean tools are also incorporated into the different steps. The methodology is data-centric with excellent tools that are powerful because they offer statistical validity [18], used to realize stable and foreseeable processes [13].

The Lean Six Sigma's DMAIC methodology to improve production process is very rarely seen in the potable water production industry. Most of the studies are focused on reporting on the comparative analysis of the laboratory results of the physical, chemical and bacteriological water quality parameters of different water products from various companies, without further investigating on the production process for the necessary improvement as applicable. This clearly shows the variance between process and laboratory results of finished water quality parameters. Process focused work has not yet been appropriately employed, which can address the root causes of process variability and enhance process capabilities in quality water production, through some comprehensive and sustainable strategies like, the Lean Six Sigma's DMAIC methodology.

2.0 MATERIALS AND METHODS

2.1. Materials

2.1.1 Physico-Chemical Analysis

The turbidity was measured using turbidimeter HACH2100Q. The titrimetric method was employed in determining the alkalinity and hardness. The pH and conductivity were determined with a pH/ conductivity meter (model: 2500wx pH/ conductivity meter). The determinations of the minerals; calcium, chloride, nitrates, sulphate, and magnesium were achieved by the use of a Spectrophotometer, Jenway 6305, while the following heavy metals; copper, iron, lead, and zinc were determined using Atomic absorption spectroscopy, ASC-7000.

Software: The minitab 2021 ® statistical software package was used to carry out both the qualitative analyses and the production of control charts to aid decision-making.

2.2. Methods

2.2.1 Data Collection

The data collected is secondary. They are the actual average weekly values of the laboratory physicochemical analysis, conducted on the treated raw water product before packaging by the water quality control department from January through December, 2020 and given in Table 1. The data were exported into the minitab statistical software application for processing.

2.2.2 Sample Size

A minimum of 25 samples is essential to be collected. The data available shows 50 samples of mean weekly sample test results with size *n* =1.

2.2.3 Process Stability Analysis

The Shewhart control chart for Individuals measurements (X-chart or I-chart) and moving range (MR) chart were used to analyze the quality parameters of the potable drinking water. This was necessary because data collection was slow or as the data were collected over some time, the output may be too homogeneous over short time intervals, most appropriate for batch processes, where the within batch variation is so small relative to between-batch variation and the sample size n =1 [8] [19] [20] [21] [22]. The limits for I-MR charts are computed using the formulae given in equations 1 to 7 below [8] [19] [21].

$$\overline{MRi} = |x_i - x_{i-1}| \quad (1)$$

$$\mathrm{UCL}(\overline{\mathrm{X}}) = \overline{\mathrm{X}} + 3\frac{\overline{MR}}{d_2} \quad (2)$$

$$\mathrm{CL}(\mathrm{X}) = \overline{\mathrm{X}} \quad (3)$$

$$\mathrm{LCL}(\overline{\mathrm{X}}) = \overline{\mathrm{X}} - 3\frac{\overline{MR}}{d_2} \quad (4)$$

Equations for the control limits of the Moving Range (MR) Chart:

$$\mathrm{UCL}(\mathrm{R}) = D_4\overline{MR} \quad (5)$$

$$\mathrm{CL}(\mathrm{R}) = \overline{\mathrm{R}} \quad (6)$$

$$\mathrm{LCL}(\mathrm{R}) = D_3\overline{MR} \quad (7)$$

Where,
$\overline{MR}$= mean of moving range of samples
UCL = upper control limit
CL = centerline
LCL = lower control limit
$\bar{\bar{X}}$= the average of the sample mean
$\overline{\mathrm{R}}$ = average range of the samples

x̄= sample mean
x_i = Sample values

d_2, D_3, and D_4 are are control chart constants based on the subgroup size of the data[1].

Table 1: Raw weekly mean values of water quality parameters from Jan. – Dec. 2020

Unit			μs/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Parameter		**pH**	**Conductivity**	**Turbidity**	**Hardness**	**Alkanity**	**Choliride**	**Tot. Dis. Solids**	**Nitrate**	**Sulphate**	**Calcium**	**Magnesium**	**Iron**	**Lead**	**Copper**	**Zinc**
Month	**Week**															
Jan	1	6.86	12	0.1	12.5	16.5	6.88	8.91	1	1.3	6.51	0.15	0.01	0	0.02	0.14
	2	6.91	11	0.08	11.6	12.1	6.92	6.23	0.63	1.14	7.21	0.14	0.04	0.02	0.02	0.09
	3	6.73	8	0.06	13	12	7.13	11.4	1.22	1.09	3.02	0.14	0.04	0.03	0.05	0.08
	4	7.04	6	0	15.1	11.9	7.45	2.03	1.04	1.05	5.13	0.14	0	0.01	0.03	0.01
Feb	5	7	15	0.11	13.4	12	8.22	1.03	1.08	1.26	5.21	0.29	0.08	0.02	0.01	0.3
	6	6.98	28.2	0.02	15	12.1	6.41	6.24	1	1.41	8.13	0.41	0.01	0.03	0.03	0.03
	7	6.63	15.4	0.01	10.2	10.7	8.09	6.13	1	1.03	3.22	0.61	0.02	0.04	0.03	0.15
	8	6.72	18.3	0	9.39	12	7.05	7.41	1.01	1	4.91	0.84	0.03	0	0.07	0.01
Mar	9	6.6	7.03	0	17.5	10	5.81	5.2	0.64	1.05	8.31	6.48	0.04	0.04	0.02	0.03
	10	6.45	8.91	0	12.3	9.64	6.92	6.01	0.32	1.12	10.1	9.21	0.08	0	0	0
	11	6.01	15.1	0.08	11.1	8.31	5.73	7.24	1.04	1.1	12.6	9.14	0.06	0.01	0	0
	12	6.5	22.1	0.16	10.3	8.94	6.44	6.53	1	1.62	15.1	13.2	0.05	0	0	0
Apr	13	6.59	19.4	0.07	12.4	14	7.32	7.11	0.87	0.81	16	14.5	0.03	0	0	0
	14	6.62	11	0.97	13.5	13.1	8.61	4.28	1.21	0.74	9.63	11.3	0.08	0	0	0
	15	6.87	9.32	1	14.6	15.6	9.22	5.96	0.43	0.95	8.11	16.1	0.07	0	0	0
	16	6.96	11	1.04	10	17.5	5.51	6.71	0.52	0.83	7.59	6.02	0.06	0	0	0
May	17	7.02	15.4	1	11.1	19	6.43	8.32	0.61	0.62	8.82	10.1	0.09	0.01	0	0
	18	7	16.3	1.2	10.2	22.4	8.65	9.44	0.92	1.06	10.2	4.11	0.02	0.02	0	0
	19	7.08	15.4	0	7.33	25.1	11	6.5	1	1.09	10.3	3.2	0.08	0	0	0
	20	7	9.81	0	22	21.9	5.08	8.12	1.08	1	11	4.16	0.04	0	0	0
June	21	6.91	10	0	19	17.4	6	4.93	0.67	1.31	9.68	4.21	0.03	0	0	0
	22	6.63	12.1	0.82	21.3	16.1	8.53	5.01	0.21	1.28	9.92	3	0.03	0	0	0
	23	6.74	10	0.7	18.2	17.1	7.41	6.28	0.41	1.01	8.51	11.2	0.06	0	0	0
	24	6.86	25.1	0.54	17.4	18.2	6.62	7.41	1.32	1.05	9.62	12.2	0.09	0	0	0
July	25	6.85	14.2	0.1	16.3	17.6	8.11	9.62	1.07	1.13	11.4	5.43	0.04	0.01	0	0.01
	26	6.9	11.3	0.08	12	23.1	5.31	8.04	1.67	1.33	12.1	1.23	0.05	0.02	0	0

Parameter		pH	Conductivity	Turbidity	Hardness	Alkanity	Choliride	Tot. Dis. Solids	Nitrate	Sulphate	Calcium	Magnesium	Iron	Lead	Copper	Zinc
Unit			μs/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Month	**Week**															
	27	7.1	10	0.01	13.4	25.1	6.92	7.43	0.95	1.14	16.4	0.92	0.05	0.03	0	0
	28	7	10.1	0.06	15.1	21.3	5.41	6.11	0.88	0.96	17.5	0.51	0.07	0.04	0	0
	29	6.82	12.2	0	17.1	20.2	6.55	7.28	1.07	0.81	19.3	0.21	0.08	0.03	0	0
	30	6.66	17	0.01	10.6	19.5	7.81	5.43	1.21	0.32	16.4	0.43	0.03	0.02	0	0.01
	31	6.63	8.93	0.31	28.4	20.1	9.61	6.1	1.11	0.41	12.1	0.31	0.06	0.01	0	0
Aug	32	7.02	10.1	0.64	19	22.2	5.19	5.41	0.96	1.21	9.83	0.68	0.07	0.01	0	0
	33	6.83	12.4	0.72	18.1	25.6	6.32	4.31	0.85	1	8.22	0.66	0.03	0.01	0	0
	34	6.8	15	0.51	11.4	19.5	5.14	6.5	0.72	0.42	6.59	0.98	0.02	0	0	0
	35	6.82	11.7	0.43	10.1	21.8	10	8.91	0.93	1.31	7.48	0.81	0.05	0.01	0	0
Sept	36	6.99	12.1	0.08	18.3	20.8	11.1	4.32	0.81	0.86	7.03	0.93	0.03	0.01	0	0
	37	7.21	14	0.11	16.4	22.2	6.51	5.11	1.02	0.62	9.08	0.74	0.05	0.01	0	0
	38	6.63	11.3	0.31	17.3	20	8.34	6.01	1.08	1.55	10	0.83	0.04	0	0	0
	39	6.98	8.66	0.44	10.5	16.2	9.62	7.03	1	1.67	11.2	0.91	0.09	0.03	0	0
Oct	40	7	13.1	0.52	9.83	22.1	6.65	7.17	1.12	1.17	12.8	0.64	0.03	0.03	0	0
	41	7.12	18.2	0	12.4	17.5	8.21	9.03	1.35	1.32	7.44	0.59	0.04	0	0	0
	42	6.77	17.1	0	11.2	16.3	7.33	4.15	1.61	1.53	6.93	0.88	0.06	0	0	0
	43	6.81	15	0	16	11.9	5.41	4.06	0.87	1.62	4.9	0.95	0.06	0	0	0
	44	6.86	10	0	19.1	14.3	6.81	6.34	0.21	1.14	6.73	0.64	0.02	0	0.01	0
Nov	45	6.67	8.93	0.19	7.21	18.2	6.92	6.78	1.05	1.31	9.31	0.95	0.01	0	0	0
	46	6.63	10.7	0.08	13.3	12.1	7.42	4.01	1	1.52	8.11	0.68	0.01	0	0	0
	47	6.92	12	1.02	12.4	11.4	5.91	5.21	0.93	1.61	6.42	0.71	0.01	0	0	0
	48	7.01	14.6	1.35	8.69	13.3	8.07	6.33	0.81	1.21	7.31	0.52	0.03	0	0	0
Dec	49	6.78	13.2	1.21	11	12	6.94	4	1.01	1.04	6.41	0.63	0.04	0	0	0
	50	6.63	13.2	0	14.3	11.8	5.28	2.93	1.32	1.11	5.2	0.74	0.01	0	0	0

Source [23]

3.0 RESULTS AND DISCUSSION

3.1 Process stability Result

The process stability analysis results of the water quality parameters are shown by the I-MR plotted charts in Figures 1 to 15. Using equations 1 to 7 given above and the minitab 2021 ® statistical software package, these charts were plotted, with the use of the measurement data on time order, from week 1 to week 50 given in Table 1.

The upper and lower control limits of the charts plotted, are the conventional limits at three sigmas on each side of the centre line (mean) and are explicitly shown in the charts. However, these Shewhart control charts are most appropriate to detect large variations and less sensitive to small variations in the process.

For improved effectiveness, some criteria have been recommended for detecting non-random patterns called runs rules. The runs rules are based on runs of consecutive points increasing/decreasing above and below the centre line. These are the tests numbering 2 to 8 given in Table 2 [19] [20]. While the use of runs rules comes with improving the ability of the control charts to detect small variations they can significantly ruin the in-control average run length. Therefore, caution needs to be employed in their use [19].

Table 3 shows a summary of the parameters and the I-MR plotted charts failed tests, which occurred at various points in time (week). It reveals that, the pH failed at 4 different tests, conductivity at 1, turbidity at 5, total hardness at 4, alkalinity at 5, chloride at 1, total dissolved solids (TDS) at 2, nitrates at 3, sulphate at 4, calcium at 5, magnesium at 6, iron at 1, lead at 5, copper at 5 and zinc at 5.

The charts indicate that the production line of the water factory is statistically unstable, for the period under consideration. This is indicative of the presence of assignable causes of variability. It is, therefore, required that analyses and remedial actions be done to remove the assignable causes to bring the process back to stable state.

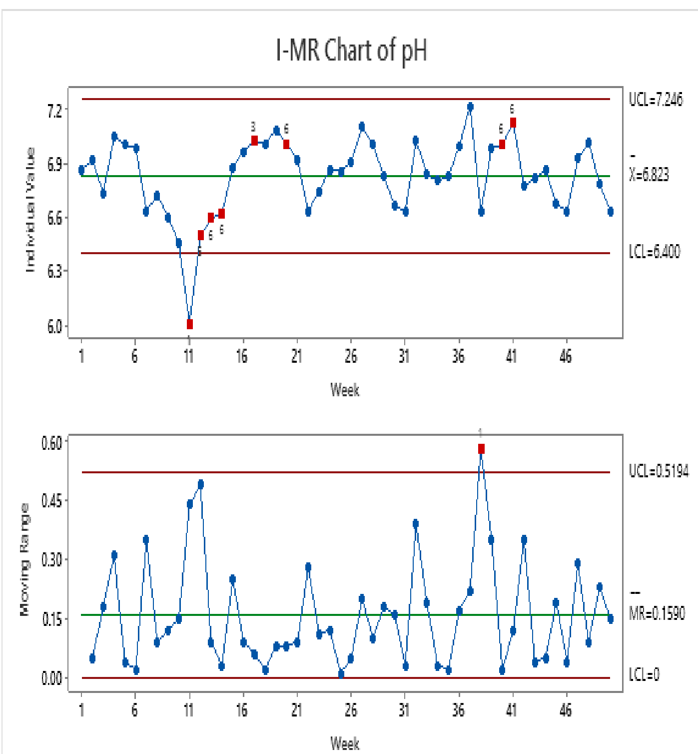

Figure 1: I-MR chart of pH

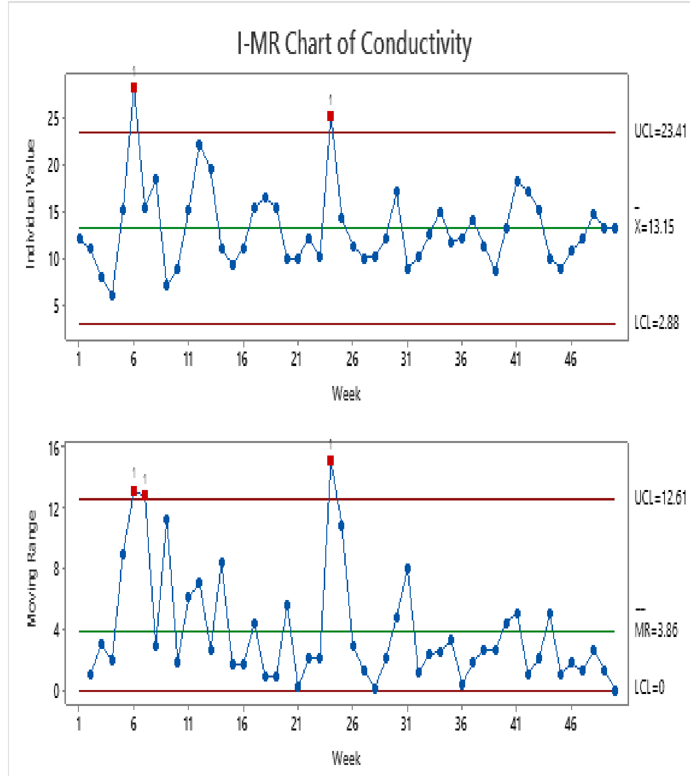

Figure 2: I-MR chart of Conductivity

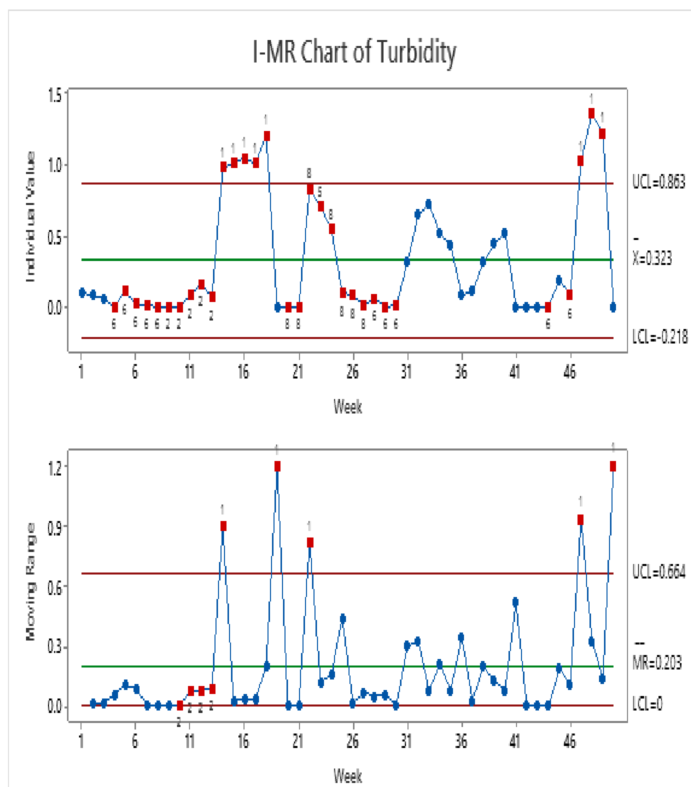

Figure 3: I-MR chart of Turbidity

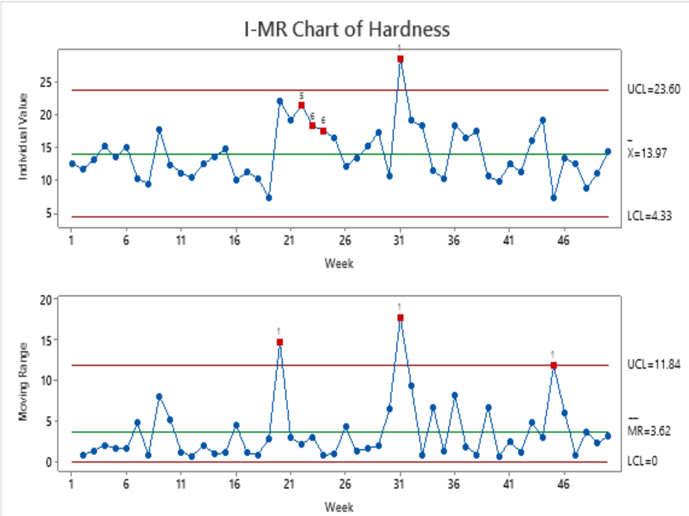

Figure 4: I-MR chart of Hardness

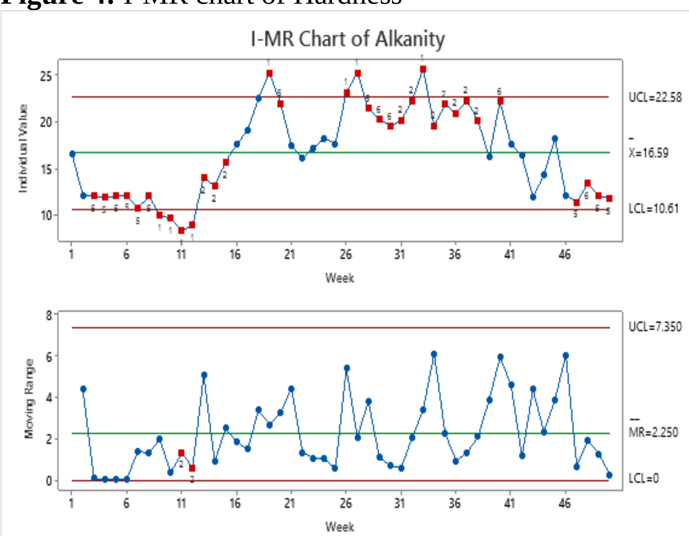

Figure 5: I-MR chart of Alkalinity

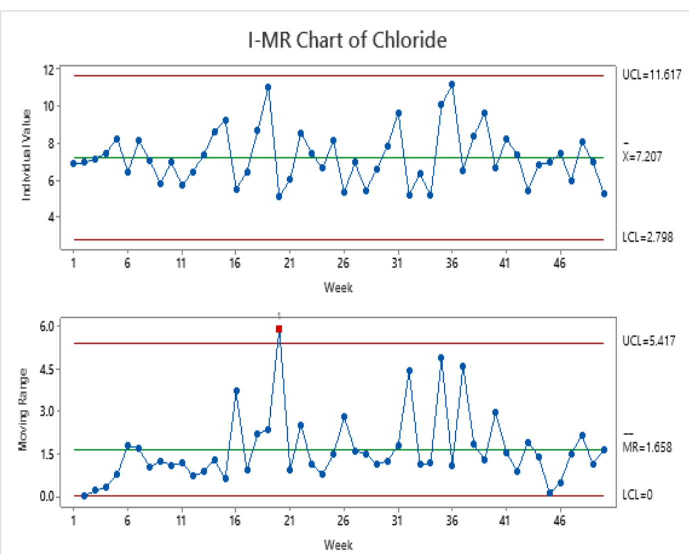

Figure 6: I-MR chart of Chloride

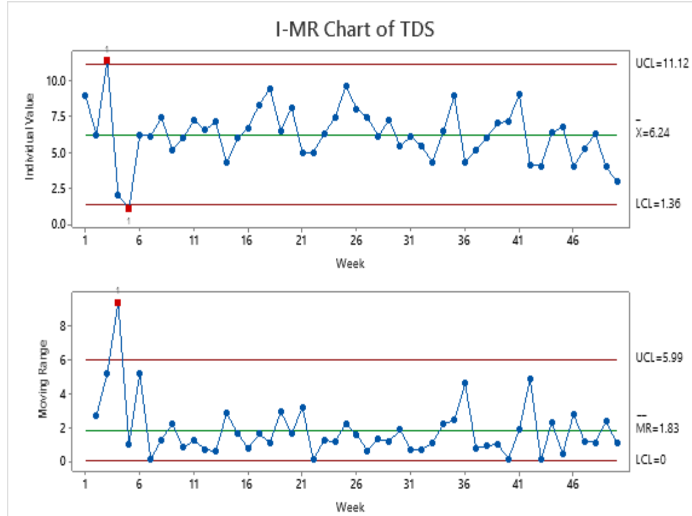

Figure 7: I-MR chart of TDS

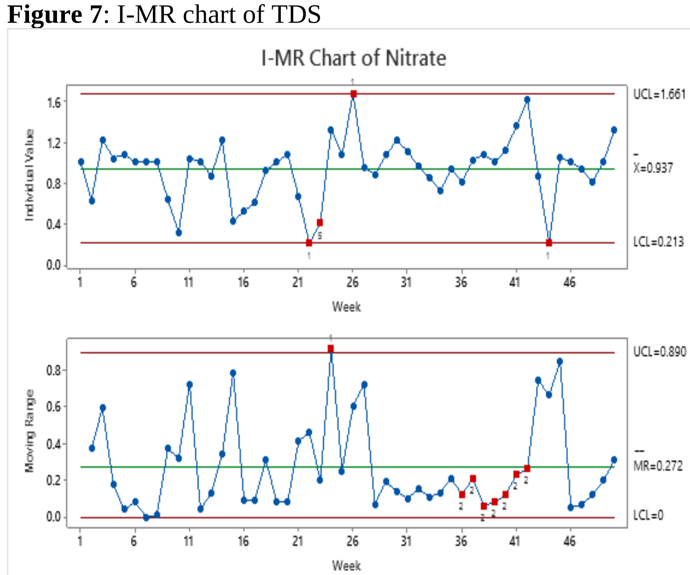

Figure 8: I-MR chart of Nitrate

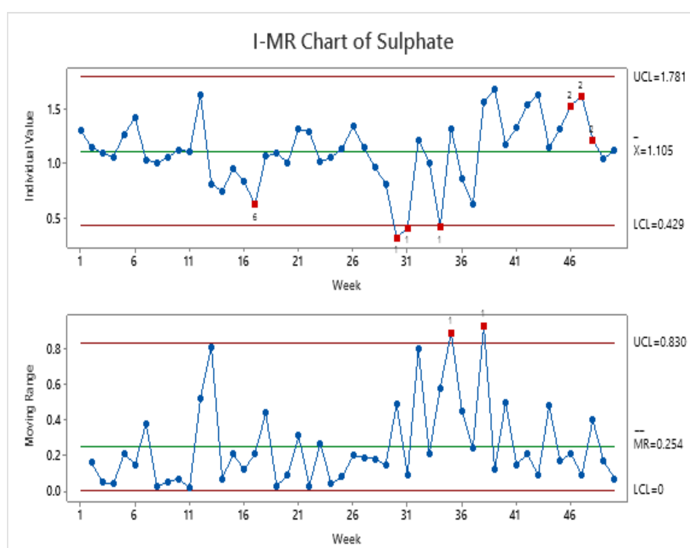

Figure 9: I-MR chart of Sulphate

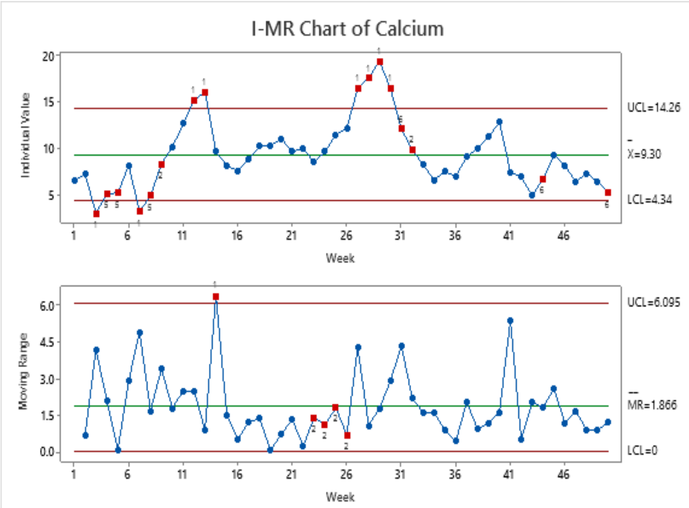

Figure 10: I-MR chart of Calcium

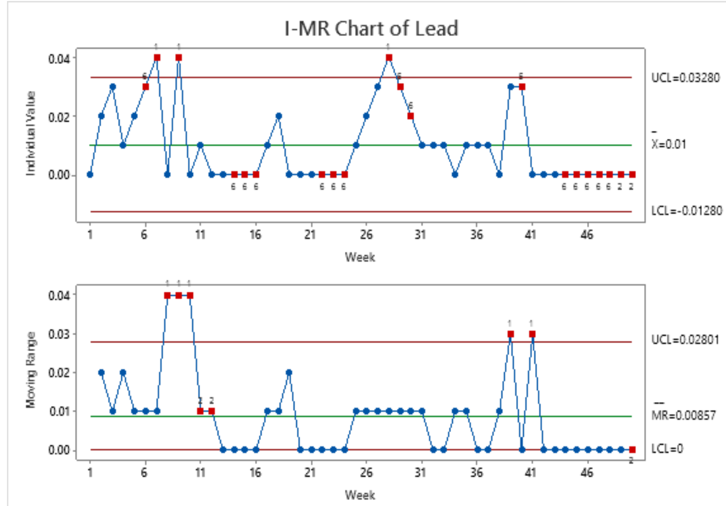

Figure 13: I-MR chart of Lead

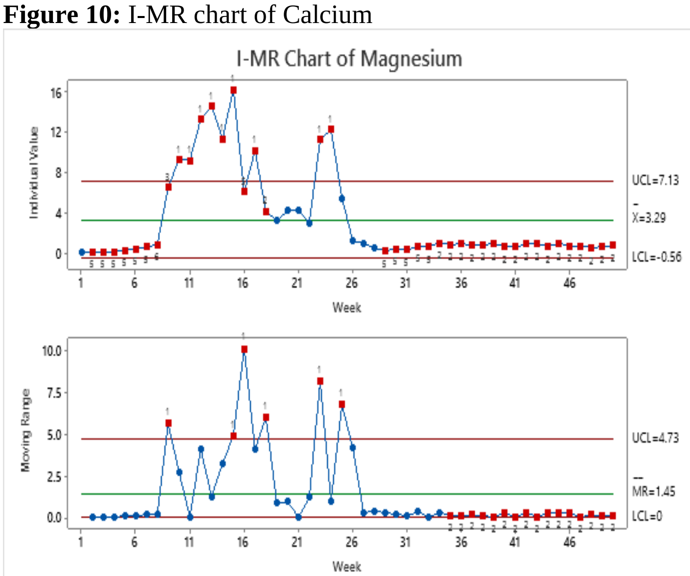

Figure 11: I-MR chart of Magnesium

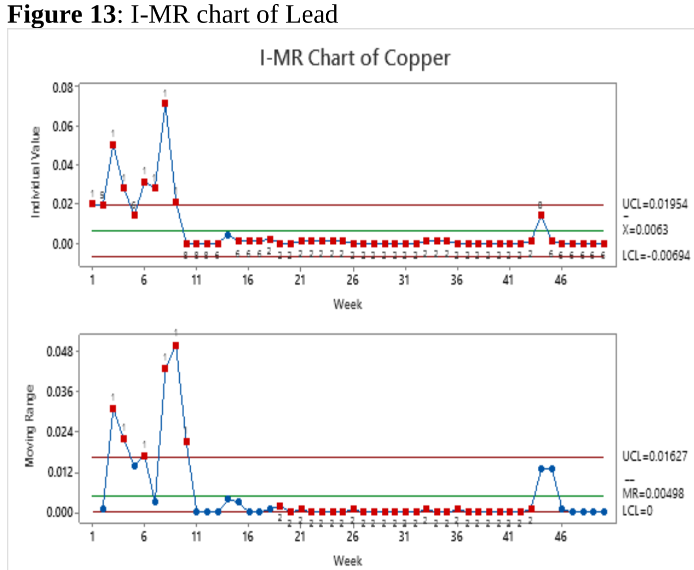

Figure 14: I-MR chart of Copper

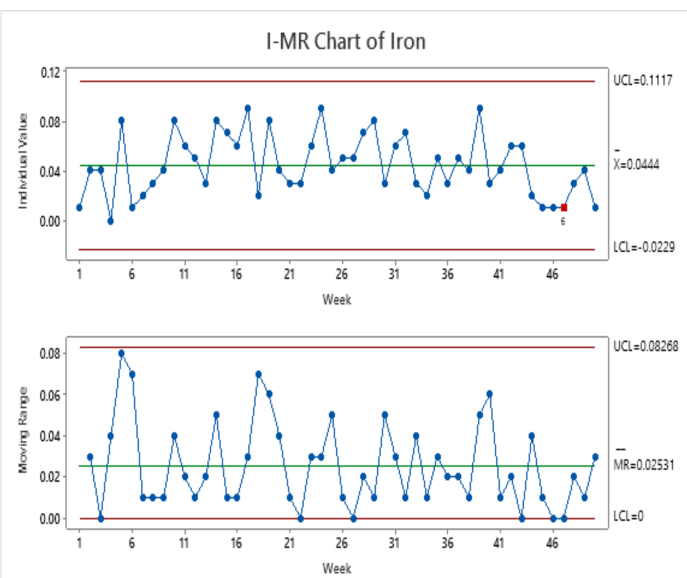

Figure 12: I-MR chart of Iron

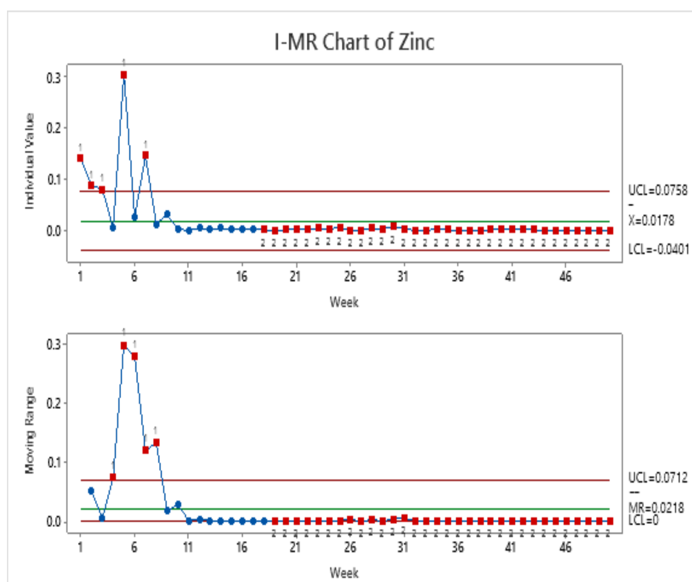

Figure 15: I-MR chart of Zinc

Table 2: Control Chart Run Test Description

Test	Description
1	One point more than 3.00 standard deviations from center line.
2	9 points in a row on same side of center line.
3	6 points in a row all increasing or all decreasing.
4	4 out of 5 points more than 1 standard deviation from center line (on one side of CL)
5	2 out of 3 points more than 2 standard deviations from center line (on one side of CL).
6	4 out of 5 points more than 1 standard deviation from center line (on one side of CL).
7	15 points within 1 standard deviation of center line (above and below CL).
8	8 points in a row more than 1 standard deviation from center line (above and below

Source: [19]

Table 3: Parameters and failed tests

I-MRChart Tests	pH	Conductivity	Turbidity	Hardness	Alkanity	Choliride	Total Dissolved Solids	Nitrate	Sulphate	Calcium	Magnesium	Iron	Lead	Copper	Zinc
1	Failed	Failed	Failed	Failed	Failed	Failed	Failed	Failed	Failed	Failed	Failed		Failed	Failed	Failed
2			Failed		Failed			Failed	Failed	Failed	Failed		Failed	Failed	Failed
3	Failed									Failed	Failed				
4															
5	Failed		Failed	Failed	Failed		Failed	Failed	Failed	Failed	Failed		Failed	Failed	Failed
6	Failed		Failed	Failed	Failed				Failed	Failed	Failed	Failed	Failed	Failed	Failed
7															Failed
8			Failed		Failed						Failed		Failed	Failed	
Total No.	4	1	5	3	5	1	2	3	4	5	6	1	5	5	5

4.0 CONCLUSION

The research results showed that the water production process is not stable, which is indicative of assignable causes of variability in the production line for all the parameters. Hence, there is a high chance of an unexpected level of process variability and also a significantly high level of naturally occurring variability in the processes.

5.0 RECOMMENDATION

This research study, as shown by the I-MR charts, has established that assignable causes are attributed to the causes of process variability. Therefore, there is need to carry out investigations to know the causes and take action to correct them. This could be achieved by deploying the appropriate tools in the analysis, improvement and control phases of the lean six sigma (DMAIC) methodology, which could not be covered under this study, due to ethical issues.

REFERENCES

[1] Ihunwo K. C. and Kinigoma B. S. "Management of the Production Process of A Water Bottling Plant To Improve Quality: A Case Study", *International Journal of Advanced Academic Research Engineering*, 2016, p. 2(2).

[2] Kandampully, J. "Service quality to service loyalty: A relationship that goes beyond customer services". *Total Quality Management*, 9(6), 1998, pp, 431-443.

[3] Gibbons, P. M. "The development of a value improvement model for repetitive processes (Doctoral dissertation, University of Bristol)", 2011.

[4] Salah S., J. A. Carretero and A. Rahim, "The integration of Quality Management and continuous improvement methodologies with management systems", *International Journal of Productivity and Quality Management*, 6(3), 2010, pp, 269-288

[5] Smętkowska, M., & Mrugalska, B. "Using Six Sigma DMAIC to improve the quality of the production process: a case study". *Procedia-Social and Behavioral Sciences*, 238, 2018, pp, 590-596.

[6] Chugani, N., Kumar, V., Garza-Reyes, J.A., Rocha-Lona, L., Upadhyay, A. "Investigating the Green Impact of Lean, Six Sigma, and Lean Six Sigma: A Systematic Literature Review*", International Journal of Lean Six Sigma*, 8(1), 2016, pp,7-32

[7] Titov, S., Nikulchev, E., Bubnov, G., & Biryukov, A. "Impact of Lean Production Initiatives on Quality: Theoretical Analysis and Empirical Research", *Quality-Access to Success*, 1(150), 2016, pp, 57-60.

[8] Krishnamoorthi, K. S., Krishnamoorthi, V. R., and Pennathur, A. "A First Course in quality engineering: integrating statistical and management methods of quality". CRC press, 2019. ISBN 9781498764216,

[9] Supriyanto, H., & Maftuhah, D. I. (2017). "A lean six-sigma manufacturing process case study" *International Journal of Mechanical Engineering and Technology*, 8(7), 2017, pp, 498-509.

[10] Rathilall, R. and Singh, S. "A Lean Six Sigma framework to enhance the competitiveness in selected automotive component manufacturing organizations". *South African journal of economic and management sciences*, 21(1), 2018, pp, 1-13.

[11] Tiberiu Dragusin (2013): "Six Sigma Revealed by International Six Sigma Institute"; Training Book, 2nd edition.

[12] Drohomeretski, E., Gouvea da Costa, S. E., Pinheiro de Lima, E., and Garbuio, P. A. D. R. Lean, "Six Sigma and Lean Six Sigma: an analysis based on operations strategy". *International Journal of Production Research*, 52(3), 2014, pp, 804-824.

[13] Laureani, A., and Antony, J. "Leadership and Lean Six Sigma: a systematic literature review" *Total Quality Management & Business Excellence*, *30*(1-2), 2019, pp.53-81.

[14] Omoush, M. M. "Lean Six Sigma effect on the Quality of the Products in Jordanian Food Companies: The Moderating Role of the Manufacturing Process". *International Review of Management and Marketing*, *10*(6), 2020, pp 1.

[15] Shirey, W. T., Sullivan, K. T., Lines, B., & Smithwick, J. "Application of lean six sigma to improve service in healthcare facilities management: a case study". *Journal of Facility Management Education and Research*,*1*(1), 2017, pp, 9-18.

[16] Supriyanto, H., & Maftuhah, D. I. "A lean six-sigma manufacturing process case study". *International Journal of Mechanical Engineering and Technology*, *8*(7), 2017, pp, 498-509.

[17] Huval, O. P.. "*Lean Six Sigma Methodology Used to Improve Machine Availability in a Manufacturing Process"*. University of Louisiana at Lafayette, 2016.

[18] Salah, S. "Lean Six Sigma and innovation: comparison and relationship", *International Journal of Business Excellence*, 13(4), 2018, pp, 479-493

[19] Smeti, E. M., Thanasoulias, N. C., Kousouris, L. P., & Tzoumerkas, P. C. (2007): An approach for the application of statistical process control techniques for quality improvement of treated water. *Desalination*, 213(1-3), 2007, pp, 273-281.

[20] Montgomery, D. C. "Introduction to statistical quality control". John Wiley & Sons. Sixth edition. ISSN: 978-0-470-16992-6, 2016.

[21] Pyzdek T. and Keller P. A. "The Six Sigma Handbook; A Complete Guide for Green Belts, Black Belts, and Managers at All Levels", 3rd ed. McGraw-Hill, New York, 2010.

[22] Erameh, A. A., Raji, N. A., Durojaye, R. O., & Yussouff, A. A. "Process capability analysis of a centre lathe turning process" *Engineering*, *8*(03), 2016, pp, 79.

[23] Quality Control Department, XYX water factory.