

DAFTAR PUSTAKA

- Abu-Shawiesh, M. O. A. (2008). A Simple Robust Control Chart Based on MAD. *Journal of Mathematics and Statistics*, 4(2), 102–107.
- Burgess, P. R., Sunmola, F. T., & Wertheim-Heck, S. (2023). A Review of Supply Chain Quality Management Practices in Sustainable Food Networks. *Heliyon*, 9(11), 1–25. <https://doi.org/10.1016/j.heliyon.2023.e21179>
- Facchinetti, S. (2009). A Procedure to Find Exact Critical Values of Kolmogorov-Smirnov Test. *Statistica Applicata – Italian Journal of Applied Statistics*, 21, 337–359.
- Fitriana, N., & Mufida, M. (2024). Pengukuran Kadar Keasaman (pH) pada Budidaya Ikan Lele di Desa Lumbangsari Kecamatan Bululawang Kota Malang sebagai Metode Alternatif untuk Mencegah Tumbuhnya Bakteri Patogen. *ALAMTANA: Jurnal Pengabdian Masyarakat UNW Mataram*, 5(1), 55–64. <https://doi.org/10.51673/jaltn.v5i1.2157>
- Guarnieri, J. P., Souza, A. M., Jacobi, L. F., Reichert, B., & da Veiga, C. P. (2019). Control Chart Based on Residues: Is a Good Methodology to Detect Outliers? *Journal of Industrial Engineering International*, 15, 119–130. <https://doi.org/10.1007/s40092-019-00324-0>
- Hermansyah, Derdian, E., & Trias Pontia, F. W. (2017). Rancangan Bangun Pengendali pH Air untuk Pembudidayaan Ikan Lele Berbasis Mikrokontroler ATmega16. *Jurnal Teknik Elektro Universitas Tanjungpura*, 1–13. <http://octopart.com/hrs4-s->
- Imran, M., Sun, J., Zaidi, F. S., Abbas, Z., & Nazir, H. Z. (2023). Effect of Measurement Error on the Multivariate CUSUM Control Chart for Compositional Data. *CMES - Computer Modeling in Engineering and Sciences*, 136(2), 1207–1257. <https://doi.org/10.32604/cmescs.2023.025492>
- Kafadar, K. (1982). The Efficiency of the Biweight as a Robust Estimator of Location. *JOURNAL OF RESEARCH of the Notional Bureau of Standards*, 88(2), 105–116.
- Khoo, M. B. C., Castagliola, P., Liew, J. Y., Teoh, W. L., & Maravelakis, P. E. (2016). A Study on EWMA Charts with Runs Rules - the Markov Chain Approach. *Communications in Statistics - Theory and Methods*, 45(14), 4156–4180. <https://doi.org/10.1080/03610926.2014.917187>
- Khoo, M. B. C., & Sim, S. Y. (2006). A Robust Exponentially Weighted Moving Average Control Chart for the Process Mean. *Journal of Modern Applied Statistical Methods*, 5(2), 464–474. <https://doi.org/10.22237/jmasm/1162354800>
- Kolmogorov, A. (1992). On the Empirical Determination of a Distribution Function. *Breakthroughs in statistics: Methodology and distribution*, 106–113.
- Lax, D. A. (1985). Robust estimators of scale: Finite-sample performance in long-tailed symmetric distributions. *Journal of the American Statistical Association*, 80(391), 736–741. <https://doi.org/10.1080/01621459.1985.10478177>
- Maravelakis, P. E., Panaretos, J., & Psarakis, S. (2010). EWMA Chart and Measurement Error. *Journal of Applied Statistics*, 31(4), 445–455. <https://doi.org/10.1080/02664760410001681738>

- Mashuri, M., Suharsono, A., Wibawati, W., Ahsan, M., Khusna, H., Aksioma, D. F., & Suhermi, N. (2022). Pengendalian Kualitas Statistika Dasar bagi Staf Quality Assurance PT Semen Indonesia (Persero) Tbk. *Sewagati*, 6(2), 147–158. <https://doi.org/10.12962/j26139960.v6i2.34>
- Montgomery, D. C. (2012). *Introduction to Statistical Quality Control, 7th Edition* (J. Welter, S. Hong, L. Sapira, & C. Teja, Ed.; 7 ed.). John Wiley & Sons, Inc.
- Mubarak, R. H., & Fauziyah. (2023). Analisis Pengendalian Kualitas dengan Statistic Quality Control (SQC) untuk Mengurangi Risiko Kerusakan Produk Beras di UD. Mulya Jaya. *Journal of Business and Halal Industry*, 1(2), 1–18. <https://economics.pubmedia.id/index.php/jbhi>
- Nazia, S., Fuad, M., & Safrizal. (2023). Peranan Statistical Quality Control (SQC) dalam Pengendalian Kualitas: Studi Literatur. *Jurnal Mahasiswa Akuntansi Samudra (JMAS)*, 4(3), 125–138.
- Nurfauzi, Y., Taime, H., Hanafiah, H., Yusuf, M., & Asir, M. (2023). Literature Review: Analysis of Factors Influencing Purchasing Decisions, Product Quality And Competitive Pricing Literature Review: Analisis Faktor yang Mempengaruhi Keputusan Pembelian, Kualitas Produk dan Harga Kompetitif. *Management Studies and Entrepreneurship Journal*, 4(1), 183–188. <http://journal.yrpiiku.com/index.php/msej>
- Nurhidayat, R. (2020). Pengendalian Kualitas Air pada Budidaya Ikan Lele Jenis Mutiara. *Jurnal Ilmiah Mahasiswa Kendali dan Listrik*, 1(2), 42–50. <https://doi.org/10.33365/jimel.v1i1>
- Olayiwola, R. K., Tuomi, V., Strid, J., & Nahan-Suomela, R. (2024). Impact of Total Quality Management on Cleaning Companies in Finland: A Focus on Organisational Performance and Customer Satisfaction. *Cleaner Logistics and Supply Chain*, 10, 1–9. <https://doi.org/10.1016/j.clscn.2024.100139>
- Prabawani, N. A., Mashuri, M., & Irhamah. (2020). Performance of Robust EWMA Control Chart for Variability Process Using Non-Normal Data. *Journal of Physics: Conference Series*, 1511(1), 1–7. <https://doi.org/10.1088/1742-6596/1511/1/012054>
- Purwanto, D., Soemanto, & Septiari, R. (2022). Pengendalian Kualitas dengan Menggunakan Metode Statistical Quality Control Guna Meminimalisasi Produk Gagal pada PT. Malindo Intitama Raya. *Jurnal Mahasiswa Teknik Industri*, 5(2), 152–159. <https://ejournal.itn.ac.id/index.php/valtech/article/view/5490>
- Razalee, A. S., Mohamed Ali, N., Kiem, K. S., & Ali, N. (2021). A Comparison between Modified EWMA Control Charts Using Different Robust Estimators. *Advances in Mathematics: Scientific Journal*, 10(1), 37–44. <https://doi.org/10.37418/amsj.10.1.5>
- Saeed, N., & Kamal, S. (2016). The EWMA Control Chart Based on Robust Scale Estimators. *Pak.j.stat.oper.res*, 12(4), 659–672.
- Umam, M. K., Santoso, F., & Adhim, M. F. (2023). Sistem Automatic Feeder, Pemantauan Suhu dan Kendali Kadar pH di Kolam Budidaya Ikan Lele Menggunakan Aplikasi Blynk. *G-Tech: Jurnal Teknologi Terapan*, 7(4), 1233–1244. <https://doi.org/10.33379/gtech.v7i4.3028>
- Usmadi. (2020). Pengujian Persyaratan Analisis (Uji Homogenitas dan Uji Normalitas). *Inovasi Pendidikan*, 7(1), 50–62.

- Yusmar, A., Nurhadryani, Y., & Hermadi, I. (2023). Analisis Perbaikan dan Pemodelan Proses Bisnis Menggunakan Business Process Improvement pada Sistem Manajemen Budidaya Buah Agrowing. *Jurnal Teknologi Informasi dan Ilmu Komputer (JTIIK)*, 10(5), 1129–1138. <https://doi.org/10.25126/jtiik.2023107237>
- Zwetsloot, I. M. (2016). *EWMA Control Charts in Statistical Process Monitoring*. IBIS UvA. www.averhoek.nl

LAMPIRAN

Lampiran 1. Data Kandungan pH Air Budidaya Ikan Lele di Kelompok Perikanan Bina Bersama Kota Makassar

Subgrup / Pengamatan (<i>i</i>)	Sampel bak pembibitan (<i>j</i>)									
	1	2	3	4	5	6	7	8	9	10
1	8	7.9	7.7	8	6.7	8	7.9	8.2	8	7.6
2	7.9	7.85	7.9	8	7.9	7.9	7.4	7.95	8.15	8.05
3	7.9	7.7	7.8	8	6.8	8	7.9	8.3	8.1	8.1
4	7.9	7.8	7.8	7.95	7.9	7.9	7.4	7.9	8.15	8.1
5	8	7.8	7.7	8	6.8	7.9	7.9	8.1	8	8.1
6	7.85	7.8	7.85	8	7.9	7.9	7.4	7.95	8.15	8.1
7	7.85	7.85	7.8	8	7.9	7.9	7.4	8	8.15	8.1
8	7.9	7.9	7.75	8	7.9	7.9	7.35	8	8.15	8.1
9	7.85	7.85	7.9	8	7.9	7.95	7.4	8	8.15	8.1
10	6.8	7.9	7.7	8	6.8	7.9	7.9	8	8	8
11	7.9	7.7	7.9	8	6.4	7.9	8	8.1	8	8
12	7.9	7.85	7.75	8	7.9	7.9	7.4	7.95	8.15	8.1
13	7.85	7.85	7.85	7.95	7.9	7.9	7.4	7.95	8.15	8.05
14	7.8	7.85	7.8	7.95	7.9	7.9	7.4	7.95	8.15	8.05
15	7.8	7.8	7.8	7.9	6.8	7.8	7.8	6.8	7.9	6.8
16	7.9	7.8	7.8	7.9	6.8	7.8	7.9	8.1	8	8.1
17	8	7.7	7.9	8	6.6	7.8	7.9	8.2	8	8.1
18	7.9	7.9	7.9	8	7.9	7.9	7.3	7.95	8.15	8.1
19	7.2	7.8	7.9	7.9	7.2	7.9	7.9	8.2	8.1	8.1
20	7.9	7.8	7.8	7.9	7.9	7.9	7.4	7.9	8.1	8.05
21	7.9	7.9	7.8	8	7.9	7.9	7.4	7.95	8.15	8.1
22	7.9	7.8	7.8	7.9	6.8	7.9	7.9	6.8	8	7.8
23	6.7	7.8	7.8	7.9	6.8	7.8	7.8	8.1	8	8.1
24	7.9	7.85	7.8	7.95	7.9	7.95	7.4	8	8.1	8.1
25	7.8	7.85	7.8	7.9	7.9	7.9	7.35	7.85	8.15	8.05
26	8	7.8	7.8	7.9	6.8	7.8	7.8	8.2	8	8
27	8	7.9	7.9	8	6.8	7.9	8	8.2	8.1	8
28	7.8	7.8	7.8	7.95	7.9	7.9	7.4	7.85	8.15	8.1
29	6.6	7.8	7.8	7.9	6.8	8	7.8	8.4	7.9	8.1
30	7.9	7.9	7.9	8	6.6	8	7.9	8.4	8	8.1

Lampiran 2. Nilai x_i , dan IQR untuk Setiap Subgrup Pengamatan

i	\bar{x}_i	IQR
1	7,8	0.250
2	7,9	0.087
3	7,86	0.250
4	7,88	0.113
5	7,83	0.175
6	7,89	0.138
7	7,895	0.150
8	7,895	0.100
9	7,91	0.138
10	7,7	0.250
11	7,79	0.100
12	7,89	0.125
13	7,885	0.100
14	7,875	0.138
15	7,52	0.750
16	7,81	0.175
17	7,82	0.175
18	7,9	0.087
19	7,82	0.225
20	7,865	0.075
21	7,9	0.087
22	7,66	0.100
23	7,68	0.175
24	7,895	0.125
25	7,855	0.088
26	7,81	0.200
27	7,88	0.100
28	7,865	0.138
29	7,71	0.175
30	7,87	0.100
Rata-Rata	7,8287	0,1629

Lampiran 3. Nilai x_i , Median, MAD, dan Biweight untuk Setiap Subgrup Pengamatan

i	\bar{x}_i	Median	MAD	Biweight
1	7,8	7.95	0.074	0.189
2	7,9	7.90	0.074	0.131
3	7,86	7.95	0.222	0.291
4	7,88	7.90	0.111	0.176
5	7,83	7.95	0.148	0.157
6	7,89	7.90	0.111	0.179
7	7,895	7.90	0.148	0.194
8	7,895	7.90	0.148	0.202
9	7,91	7.93	0.111	0.168
10	7,7	7.90	0.148	0.171
11	7,79	7.95	0.074	0.114
12	7,89	7.90	0.111	0.185
13	7,885	7.90	0.074	0.129
14	7,875	7.90	0.111	0.171
15	7,52	7.80	0.074	0.067
16	7,81	7.90	0.148	0.150
17	7,82	7.95	0.148	0.161
18	7,9	7.90	0.037	0.089
19	7,82	7.90	0.222	0.343
20	7,865	7.90	0.074	0.126
21	7,9	7.90	0.111	0.176
22	7,66	7.85	0.074	0.084
23	7,68	7.80	0.222	0.423
24	7,895	7.93	0.111	0.162
25	7,855	7.88	0.074	0.138
26	7,81	7.85	0.148	0.194
27	7,88	8.00	0.148	0.114
28	7,865	7.88	0.111	0.186
29	7,71	7.85	0.148	0.301
30	7,87	7.95	0.074	0.113
Rata-Rata	7,8287	7,9017	0,1198	0,1762

Lampiran 4. Titik Plot, UCL, LCL, CL, dan W_i Peta Kendali REWMA dengan estimator IQR

i	$\lambda = 0,01$				Ket.	$\lambda = 0,25$				Ket.
	UCL	LCL	CL	W_i		UCL	LCL	CL	W_i	
1	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.822	IN
2	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.841	IN
3	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.846	IN
4	7.837	7.820	7.829	7.830	IN	7.873	7.784	7.829	7.854	IN
5	7.837	7.820	7.829	7.830	IN	7.873	7.784	7.829	7.848	IN
6	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.859	IN
7	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.868	IN
8	7.837	7.820	7.829	7.832	IN	7.873	7.784	7.829	7.875	OUT
9	7.837	7.820	7.829	7.833	IN	7.873	7.784	7.829	7.883	OUT
10	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.838	IN
11	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.826	IN
12	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.842	IN
13	7.837	7.820	7.829	7.832	IN	7.873	7.784	7.829	7.853	IN
14	7.837	7.820	7.829	7.832	IN	7.873	7.784	7.829	7.858	IN
15	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.774	OUT
16	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.783	OUT
17	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.792	IN
18	7.837	7.820	7.829	7.830	IN	7.873	7.784	7.829	7.819	IN
19	7.837	7.820	7.829	7.830	IN	7.873	7.784	7.829	7.819	IN
20	7.837	7.820	7.829	7.830	IN	7.873	7.784	7.829	7.831	IN
21	7.837	7.820	7.829	7.831	IN	7.873	7.784	7.829	7.848	IN
22	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.801	IN
23	7.837	7.820	7.829	7.827	IN	7.873	7.784	7.829	7.771	OUT
24	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.802	IN
25	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.815	IN
26	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.814	IN
27	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.830	IN
28	7.837	7.820	7.829	7.829	IN	7.873	7.784	7.829	7.839	IN
29	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.807	IN
30	7.837	7.820	7.829	7.828	IN	7.873	7.784	7.829	7.823	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 4. Titik Plot, UCL, LCL, CL, dan W_i Peta Kendali REWMA dengan estimator IQR (Lanjutan)

i	$\lambda = 0,5$				Ket.	$\lambda = 0,75$				Ket.
	UCL	LCL	CL	W_i		UCL	LCL	CL	W_i	
1	7.897	7.761	7.829	7.814	IN	7.920	7.737	7.829	7.807	IN
2	7.897	7.761	7.829	7.857	IN	7.920	7.737	7.829	7.877	IN
3	7.897	7.761	7.829	7.859	IN	7.920	7.737	7.829	7.864	IN
4	7.897	7.761	7.829	7.869	IN	7.920	7.737	7.829	7.876	IN
5	7.897	7.761	7.829	7.850	IN	7.920	7.737	7.829	7.842	IN
6	7.897	7.761	7.829	7.870	IN	7.920	7.737	7.829	7.878	IN
7	7.897	7.761	7.829	7.882	IN	7.920	7.737	7.829	7.891	IN
8	7.897	7.761	7.829	7.889	IN	7.920	7.737	7.829	7.894	IN
9	7.897	7.761	7.829	7.899	OUT	7.920	7.737	7.829	7.906	IN
10	7.897	7.761	7.829	7.800	IN	7.920	7.737	7.829	7.751	IN
11	7.897	7.761	7.829	7.795	IN	7.920	7.737	7.829	7.780	IN
12	7.897	7.761	7.829	7.842	IN	7.920	7.737	7.829	7.863	IN
13	7.897	7.761	7.829	7.864	IN	7.920	7.737	7.829	7.879	IN
14	7.897	7.761	7.829	7.869	IN	7.920	7.737	7.829	7.876	IN
15	7.897	7.761	7.829	7.695	OUT	7.920	7.737	7.829	7.609	OUT
16	7.897	7.761	7.829	7.752	OUT	7.920	7.737	7.829	7.760	IN
17	7.897	7.761	7.829	7.786	IN	7.920	7.737	7.829	7.805	IN
18	7.897	7.761	7.829	7.843	IN	7.920	7.737	7.829	7.876	IN
19	7.897	7.761	7.829	7.832	IN	7.920	7.737	7.829	7.834	IN
20	7.897	7.761	7.829	7.848	IN	7.920	7.737	7.829	7.857	IN
21	7.897	7.761	7.829	7.874	IN	7.920	7.737	7.829	7.889	IN
22	7.897	7.761	7.829	7.767	IN	7.920	7.737	7.829	7.717	OUT
23	7.897	7.761	7.829	7.724	OUT	7.920	7.737	7.829	7.689	OUT
24	7.897	7.761	7.829	7.809	IN	7.920	7.737	7.829	7.844	IN
25	7.897	7.761	7.829	7.832	IN	7.920	7.737	7.829	7.852	IN
26	7.897	7.761	7.829	7.821	IN	7.920	7.737	7.829	7.821	IN
27	7.897	7.761	7.829	7.851	IN	7.920	7.737	7.829	7.865	IN
28	7.897	7.761	7.829	7.858	IN	7.920	7.737	7.829	7.865	IN
29	7.897	7.761	7.829	7.784	IN	7.920	7.737	7.829	7.749	IN
30	7.897	7.761	7.829	7.827	IN	7.920	7.737	7.829	7.840	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 4. Titik Plot, UCL, LCL, CL, dan W_i Peta Kendali REWMA dengan estimator IQR (Lanjutan)

i	$\lambda = 1$				Ket.
	UCL	LCL	LCL	W_i	
1	7.946	7.711	7.829	7.800	IN
2	7.946	7.711	7.829	7.900	IN
3	7.946	7.711	7.829	7.860	IN
4	7.946	7.711	7.829	7.880	IN
5	7.946	7.711	7.829	7.830	IN
6	7.946	7.711	7.829	7.890	IN
7	7.946	7.711	7.829	7.895	IN
8	7.946	7.711	7.829	7.895	IN
9	7.946	7.711	7.829	7.910	IN
10	7.946	7.711	7.829	7.700	OUT
11	7.946	7.711	7.829	7.790	IN
12	7.946	7.711	7.829	7.890	IN
13	7.946	7.711	7.829	7.885	IN
14	7.946	7.711	7.829	7.875	IN
15	7.946	7.711	7.829	7.520	OUT
16	7.946	7.711	7.829	7.810	IN
17	7.946	7.711	7.829	7.820	IN
18	7.946	7.711	7.829	7.900	IN
19	7.946	7.711	7.829	7.820	IN
20	7.946	7.711	7.829	7.865	IN
21	7.946	7.711	7.829	7.900	IN
22	7.946	7.711	7.829	7.660	OUT
23	7.946	7.711	7.829	7.680	OUT
24	7.946	7.711	7.829	7.895	IN
25	7.946	7.711	7.829	7.855	IN
26	7.946	7.711	7.829	7.810	IN
27	7.946	7.711	7.829	7.880	IN
28	7.946	7.711	7.829	7.865	IN
29	7.946	7.711	7.829	7.710	OUT
30	7.946	7.711	7.829	7.870	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 5. Titik Plot, UCL, LCL, CL, dan Y_i Peta Kendali REWMA dengan estimator *Biweight*

i	$\lambda = 0,01$				Ket.	$\lambda = 0,25$				Ket.
	UCL	LCL	CL	Y_i		UCL	LCL	CL	Y_i	
1	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.822	IN
2	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.841	IN
3	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.846	IN
4	7.841	7.817	7.829	7.830	IN	7.892	7.765	7.829	7.854	IN
5	7.841	7.817	7.829	7.830	IN	7.892	7.765	7.829	7.848	IN
6	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.859	IN
7	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.868	IN
8	7.841	7.817	7.829	7.832	IN	7.892	7.765	7.829	7.875	IN
9	7.841	7.817	7.829	7.833	IN	7.892	7.765	7.829	7.883	IN
10	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.838	IN
11	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.826	IN
12	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.842	IN
13	7.841	7.817	7.829	7.832	IN	7.892	7.765	7.829	7.853	IN
14	7.841	7.817	7.829	7.832	IN	7.892	7.765	7.829	7.858	IN
15	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.774	IN
16	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.783	IN
17	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.792	IN
18	7.841	7.817	7.829	7.830	IN	7.892	7.765	7.829	7.819	IN
19	7.841	7.817	7.829	7.830	IN	7.892	7.765	7.829	7.819	IN
20	7.841	7.817	7.829	7.830	IN	7.892	7.765	7.829	7.831	IN
21	7.841	7.817	7.829	7.831	IN	7.892	7.765	7.829	7.848	IN
22	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.801	IN
23	7.841	7.817	7.829	7.827	IN	7.892	7.765	7.829	7.771	IN
24	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.802	IN
25	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.815	IN
26	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.814	IN
27	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.830	IN
28	7.841	7.817	7.829	7.829	IN	7.892	7.765	7.829	7.839	IN
29	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.807	IN
30	7.841	7.817	7.829	7.828	IN	7.892	7.765	7.829	7.823	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 5. Titik Plot, UCL, LCL, CL, dan Y_i Peta Kendali REWMA dengan estimator *Biweight* (Lanjutan)

i	$\lambda = 0,5$				Ket.	$\lambda = 0,75$				Ket.
	UCL	LCL	CL	Y_i		UCL	LCL	CL	Y_i	
1	7.925	7.732	7.829	7.814	IN	7.958	7.699	7.829	7.807	IN
2	7.925	7.732	7.829	7.857	IN	7.958	7.699	7.829	7.877	IN
3	7.925	7.732	7.829	7.859	IN	7.958	7.699	7.829	7.864	IN
4	7.925	7.732	7.829	7.869	IN	7.958	7.699	7.829	7.876	IN
5	7.925	7.732	7.829	7.850	IN	7.958	7.699	7.829	7.842	IN
6	7.925	7.732	7.829	7.870	IN	7.958	7.699	7.829	7.878	IN
7	7.925	7.732	7.829	7.882	IN	7.958	7.699	7.829	7.891	IN
8	7.925	7.732	7.829	7.889	IN	7.958	7.699	7.829	7.894	IN
9	7.925	7.732	7.829	7.899	IN	7.958	7.699	7.829	7.906	IN
10	7.925	7.732	7.829	7.800	IN	7.958	7.699	7.829	7.751	IN
11	7.925	7.732	7.829	7.795	IN	7.958	7.699	7.829	7.780	IN
12	7.925	7.732	7.829	7.842	IN	7.958	7.699	7.829	7.863	IN
13	7.925	7.732	7.829	7.864	IN	7.958	7.699	7.829	7.879	IN
14	7.925	7.732	7.829	7.869	IN	7.958	7.699	7.829	7.876	IN
15	7.925	7.732	7.829	7.695	OUT	7.958	7.699	7.829	7.609	OUT
16	7.925	7.732	7.829	7.752	IN	7.958	7.699	7.829	7.760	IN
17	7.925	7.732	7.829	7.786	IN	7.958	7.699	7.829	7.805	IN
18	7.925	7.732	7.829	7.843	IN	7.958	7.699	7.829	7.876	IN
19	7.925	7.732	7.829	7.832	IN	7.958	7.699	7.829	7.834	IN
20	7.925	7.732	7.829	7.848	IN	7.958	7.699	7.829	7.857	IN
21	7.925	7.732	7.829	7.874	IN	7.958	7.699	7.829	7.889	IN
22	7.925	7.732	7.829	7.767	IN	7.958	7.699	7.829	7.717	IN
23	7.925	7.732	7.829	7.724	OUT	7.958	7.699	7.829	7.689	OUT
24	7.925	7.732	7.829	7.809	IN	7.958	7.699	7.829	7.844	IN
25	7.925	7.732	7.829	7.832	IN	7.958	7.699	7.829	7.852	IN
26	7.925	7.732	7.829	7.821	IN	7.958	7.699	7.829	7.821	IN
27	7.925	7.732	7.829	7.851	IN	7.958	7.699	7.829	7.865	IN
28	7.925	7.732	7.829	7.858	IN	7.958	7.699	7.829	7.865	IN
29	7.925	7.732	7.829	7.784	IN	7.958	7.699	7.829	7.749	IN
30	7.925	7.732	7.829	7.827	IN	7.958	7.699	7.829	7.840	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 5. Titik Plot, UCL, LCL, CL, dan Y_i Peta Kendali REWMA dengan estimator *Biweight* (Lanjutan)

i	$\lambda = 1$				Ket.
	UCL	LCL	LCL	Y_i	
1	7.996	7.662	7.829	7.800	IN
2	7.996	7.662	7.829	7.900	IN
3	7.996	7.662	7.829	7.860	IN
4	7.996	7.662	7.829	7.880	IN
5	7.996	7.662	7.829	7.830	IN
6	7.996	7.662	7.829	7.890	IN
7	7.996	7.662	7.829	7.895	IN
8	7.996	7.662	7.829	7.895	IN
9	7.996	7.662	7.829	7.910	IN
10	7.996	7.662	7.829	7.700	IN
11	7.996	7.662	7.829	7.790	IN
12	7.996	7.662	7.829	7.890	IN
13	7.996	7.662	7.829	7.885	IN
14	7.996	7.662	7.829	7.875	IN
15	7.996	7.662	7.829	7.520	OUT
16	7.996	7.662	7.829	7.810	IN
17	7.996	7.662	7.829	7.820	IN
18	7.996	7.662	7.829	7.900	IN
19	7.996	7.662	7.829	7.820	IN
20	7.996	7.662	7.829	7.865	IN
21	7.996	7.662	7.829	7.900	IN
22	7.996	7.662	7.829	7.660	OUT
23	7.996	7.662	7.829	7.680	IN
24	7.996	7.662	7.829	7.895	IN
25	7.996	7.662	7.829	7.855	IN
26	7.996	7.662	7.829	7.810	IN
27	7.996	7.662	7.829	7.880	IN
28	7.996	7.662	7.829	7.865	IN
29	7.996	7.662	7.829	7.710	IN
30	7.996	7.662	7.829	7.870	IN

Keterangan:

IN : *In Control*

OUT : *Out of Control*

Lampiran 6. Perhitungan Nilai ARL REWMA dengan Estimator IQR

```

# Mengimpor library yang dibutuhkan
library(readxl)
library(writexl)
library(ggplot2)
library(showtext)

# Menambahkan font Roboto dari Google Fonts
font_add_google("Roboto", "roboto")
showtext_auto()

# Membaca data dari file Excel
data <- read_excel("D:/SKRIPSI/Data Skripsi Rafli.xlsx")

# Menentukan nilai m (jumlah kolom) dan num_bak (jumlah baris) dari data
m <- ncol(data) # Jumlah kolom (pengamatan per bak)
num_bak <- nrow(data) # Jumlah baris (jumlah bak)

# Definisi parameter
dn <- 1.3121 # Nilai koreksi untuk IQR
L <- 3 # Skala batas kontrol

# Fungsi untuk menghitung IQR
calculate_IQR <- function(x) {
  IQR(x, type = 7) # Menggunakan fungsi IQR bawaan
}

# Menghitung IQR untuk setiap bak (baris)
IQR_values <- apply(data, 1, calculate_IQR)

# Menghitung standar deviasi berdasarkan IQR yang dibagi dengan dn
sigma1 <- mean(IQR_values) / dn
sigma <- sigma1 / sqrt(m)

# Menghitung rata-rata keseluruhan dari setiap rata-rata bak
mean_value <- mean(rowMeans(data, na.rm = TRUE))

# Rentang nilai lambda dan k
lambda_values <- seq(0.01, 1, by = 0.01)
k_values <- seq(0, 1, by = 0.01)

# Matriks untuk menyimpan hasil ARL
ARL_results <- matrix(NA, nrow = length(k_values), ncol = length(lambda_values))
colnames(ARL_results) <- paste0("ARL untuk  $\lambda =$ ", lambda_values)
rownames(ARL_results) <- k_values

# Data frame untuk menyimpan hasil UCL, LCL, CL, dan Z_t
Nilai_REWMA_IQR <- data.frame()

# Fungsi untuk menghitung UCL, LCL, dan CL berdasarkan nilai lambda

```

Lampiran 6. Perhitungan Nilai ARL REWMA dengan Estimator IQR (Lanjutan)

```

calculate_control_limits <- function(lambda, mean_value, sigma, L) {
  sqrt_lambda <- sqrt(lambda / (2 - lambda))
  ucl <- mean_value + L * sigma * sqrt_lambda
  lcl <- mean_value - L * sigma * sqrt_lambda
  cl <- mean_value
  return(list(UCL = ucl, LCL = lcl, CL = cl))
}

# Looping untuk setiap nilai lambda dan menghitung UCL, LCL, CL, Z_t untuk
setiap nilai lambda
for (lambda in lambda_values) {

  # Menghitung batas kontrol (UCL, LCL, CL)
  control_limits <- calculate_control_limits(lambda, mean_value, sigma, L)

  # Array untuk menyimpan nilai Z_t untuk setiap bak
  Z_t <- numeric(num_bak)

  # Looping untuk setiap bak
  for (bak in 1:num_bak) {
    bak_mean <- rowMeans(data[bak, , drop = FALSE])
    if (bak == 1) {
      Z_t[bak] <- lambda * bak_mean + (1 - lambda) * mean_value
    } else {
      Z_t[bak] <- lambda * bak_mean + (1 - lambda) * Z_t[bak - 1]
    }
  }

  # Simpan hasil UCL, LCL, CL, dan Z_t ke dalam data frame
  Nilai_REWMA_IQR <- rbind(Nilai_REWMA_IQR, data.frame(
    Lambda = lambda,
    UCL = control_limits$UCL,
    LCL = control_limits$LCL,
    CL = control_limits$CL,
    Z_t = Z_t[bak]
  ))
}

# Looping untuk setiap nilai k untuk menghitung ARL
for (j in seq_along(k_values)) {
  k <- k_values[j]

  # Menghitung  $\beta$  menggunakan distribusi normal kumulatif (pnorm)
  beta <- pnorm((control_limits$UCL - (mean_value + k * sigma)) / (sigma *
sqrt(lambda / (2 - lambda)))) -
  pnorm((control_limits$LCL - (mean_value + k * sigma)) / (sigma * sqrt(lambda
/ (2 - lambda))))

  # Menghitung ARL berdasarkan  $\beta$ 
  ARL_results[j, which(lambda_values == lambda)] <- 1 / (1 - beta)
}

```

Lampiran 6. Perhitungan Nilai ARL REWMA dengan Estimator IQR (Lanjutan)

```

}
}

# Fungsi untuk menampilkan grafik peta kendali berdasarkan lambda
tampilkan_peta_kendali <- function(lambda) {
  # Filter data untuk lambda yang diinginkan
  data_lambda <- Nilai_REWMA_IQR[Nilai_REWMA_IQR$Lambda == lambda, ]

  # Periksa apakah lambda ada dalam dataset
  if (nrow(data_lambda) == 0) {
    cat("Tidak ada data untuk lambda =", lambda, "\n")
    return(NULL)
  }

  # Membuat grafik peta kendali dengan garis penghubung antar titik
  control_chart <- ggplot(data_lambda, aes(x = 1:nrow(data_lambda))) +
    geom_line(aes(y = Z_t, color = "Wi"), size = 1) + # Garis penghubung nilai Z_t
    geom_line(aes(y = UCL, color = "UCL"), size = 1, linetype = "dashed") + # Garis
UCL
    geom_line(aes(y = LCL, color = "LCL"), size = 1, linetype = "dashed") + # Garis
LCL
    geom_line(aes(y = CL, color = "CL"), size = 1, linetype = "solid") + # Garis CL
    geom_point(aes(y = Z_t, color = "Wi"), size = 3) + # Kembalikan ukuran bulatan
Z_t
    geom_point(aes(y = UCL, color = "UCL"), size = 3) + # Kembalikan ukuran
bulatan UCL
    geom_point(aes(y = LCL, color = "LCL"), size = 3) + # Kembalikan ukuran
bulatan LCL
    geom_point(aes(y = CL, color = "CL"), size = 3) + # Kembalikan ukuran bulatan
CL
    labs(title = paste("REWMA IQR  $\lambda$  =", format(lambda, digits = 2, decimal.mark =
", ")),
      x = "Observasi", y = "Nilai") + # Tambahkan judul dengan format sesuai
lambda
    scale_color_manual(values = c("Wi" = "yellow", "UCL" = "blue", "LCL" =
"orange", "CL" = "grey")) +
    theme_minimal() +
    theme(
      text = element_text(family = "roboto"), # Gunakan font Roboto
      plot.title = element_text(size = 16, face = "bold", hjust = 0.5), # Ukuran title 16,
bold, dan center
      axis.text.x = element_text(size = 10), # Ukuran teks untuk sumbu x menjadi
10
      axis.text.y = element_text(size = 10), # Ukuran teks untuk sumbu y menjadi
10
      legend.position = "right", # Posisi legenda di kanan
      legend.title = element_blank(), # Hilangkan judul legenda
      legend.text = element_text(size = 10), # Perkecil ukuran teks legenda menjadi
11

```

Lampiran 6. Perhitungan Nilai ARL REWMA dengan Estimator IQR (Lanjutan)

```

panel.border = element_rect(colour = "black", fill = NA, size = 1), # Tambah
garis pinggir hitam
plot.background = element_rect(colour = "black", fill = NA, size = 1) # Tambah
garis pinggir hitam
)

# Menampilkan grafik peta kendali
print(control_chart)
}

# Menambahkan kolom Status untuk memeriksa apakah Z_t berada di dalam atau
di luar batas kontrol
Nilai_REWMA_IQR$Status <- ifelse(Nilai_REWMA_IQR$Z_t >
Nilai_REWMA_IQR$UCL, "Out of Control",
ifelse(Nilai_REWMA_IQR$Z_t <
Nilai_REWMA_IQR$LCL, "Out of Control",
"In Control"))

# Menghitung jumlah "Out of Control" untuk setiap nilai lambda
jumlah_out_of_control <- aggregate(Status ~ Lambda, data = Nilai_REWMA_IQR,
FUN = function(x) sum(x == "Out of Control"))

# Konversi hasil ARL ke data frame
ARL_results_df_IQR <- as.data.frame(ARL_results)

tampilkan_peta_kendali(0.01)

```

Lampiran 7. Perhitungan Nilai ARL REWMA dengan Estimator *Biweight*

Sintaks REWMA Estimator Biweight

Mengimpor library yang dibutuhkan

library(readxl)

library(writexl)

library(ggplot2)

library(showtext)

Membaca data dari file Excel

data <- read_excel("D:/SKRIPSI/Data Skripsi Rafli.xlsx")

Konversi data menjadi matriks

data_matrix <- as.matrix(data)

Menentukan nilai m (jumlah kolom) dan num_bak (jumlah baris) dari data

m <- ncol(data_matrix) # Jumlah kolom (pengamatan per bak)

num_bak <- nrow(data_matrix) # Jumlah baris (jumlah bak)

L <- 3 # Nilai faktor koreksi

Menghitung rata-rata untuk setiap subgroup dan rata-rata keseluruhan dari setiap rata-rata bak

mean_per_subgrup <- rowMeans(data_matrix, na.rm = TRUE)

mean_value <- mean(mean_per_subgrup, na.rm = TRUE)

Menghitung median untuk setiap bak

median_per_subgrup <- apply(data_matrix, 1, median, na.rm = TRUE)

Menghitung MAD untuk setiap subgroup

MAD_per_subgrup <- apply(data_matrix, 1, function(x) {

T <- median(x, na.rm = TRUE) # Median dari subgroup

mad_value <- median(abs(x - T)) # Menghitung MAD tanpa faktor

konsistensi

return(mad_value * 1.4826) # Mengalikan dengan faktor konsistensi

})

Menghitung nilai U_i untuk setiap subgroup dan pengamatan U_i <- matrix(NA, nrow = num_bak, ncol = m) # Membuat matriks kosong untuk menyimpan hasil U_i

for (i in 1:num_bak) {

for (j in 1:m) {

 $U_i[i, j] <- (data_matrix[i, j] - median_per_subgrup[i]) / (9 * MAD_per_subgrup[i])$ # Rumus U_i

}

}

Melakukan pengkodisian: jika $|U_i| < 1$, nilai U_i dipertahankan, jika $|U_i| \geq 1$, U_i dikosongkan (NA) $U_i_filtered <- ifelse(abs(U_i) < 1, U_i, NA)$

Menghitung nilai pembilang untuk setiap subgroup (menggunakan Median_j)

Lampiran 7. Perhitungan Nilai ARL REWMA dengan Estimator *Biweight* (Lanjutan)

```

numerator <- numeric(num_bak) # Vektor untuk menyimpan pembilang setiap
subgrup
for (i in 1:num_bak) {
  valid_indices <- !is.na(U_i_filtered[i, ]) # Indeks pengamatan yang valid (bukan
NA)
  numerator[i] <- sqrt(sum((data_matrix[i, valid_indices] -
median_per_subgrup[i])^2 *
(1 - U_i_filtered[i, valid_indices]^2)^4))
}

# Menghitung nilai penyebut untuk setiap subgrup dengan absolut setelah
penjumlahan
denominator <- numeric(num_bak) # Vektor untuk menyimpan penyebut setiap
subgrup
for (i in 1:num_bak) {
  valid_indices <- !is.na(U_i_filtered[i, ]) # Indeks pengamatan yang valid (bukan
NA)
  denominator[i] <- abs(sum((1 - U_i_filtered[i, valid_indices]^2) *
(1 - 5 * U_i_filtered[i, valid_indices]^2)))
}

# Menghitung nilai biweight untuk setiap subgrup
biweight <- numeric(num_bak) # Vektor untuk menyimpan nilai biweight setiap
subgrup
for (i in 1:num_bak) {
  biweight[i] <- (m / (sqrt(m - 1))) * (numerator[i] / denominator[i])
}

# Menghitung rata-rata dari nilai biweight-biweight dengan penambahan sqrt(m)
mean_biweight <- mean(biweight, na.rm = TRUE) / sqrt(m)

# Menampilkan rata-rata dari nilai biweight-biweight
print(mean_biweight)

# Rentang nilai lambda dan k
lambda_values <- seq(0.01, 1, by = 0.01)
k_values <- seq(0, 1, by = 0.01)

# Matriks untuk menyimpan hasil ARL
ARL_results <- matrix(NA, nrow = length(k_values), ncol = length(lambda_values))
colnames(ARL_results) <- paste0("ARL untuk λ = ", lambda_values)
rownames(ARL_results) <- k_values

# Data frame untuk menyimpan hasil UCL, LCL, CL, dan Z_t
Nilai_REWMA_Biweight <- data.frame()

# Fungsi untuk menghitung UCL, LCL, dan CL berdasarkan nilai lambda
calculate_control_limits <- function(lambda, mean_value, mean_biweight, L) {

```

Lampiran 7. Perhitungan Nilai ARL REWMA dengan Estimator *Biweight* (Lanjutan)

```

sqrt_lambda <- sqrt(lambda / (2 - lambda))
ucl <- mean_value + L * mean_biweight * sqrt_lambda
lcl <- mean_value - L * mean_biweight * sqrt_lambda
cl <- mean_value
return(list(UCL = ucl, LCL = lcl, CL = cl))
}

# Looping untuk setiap nilai lambda
for (lambda in lambda_values) {

  # Menghitung batas kontrol (UCL, LCL, CL)
  control_limits <- calculate_control_limits(lambda, mean_value, mean_biweight,
L)

  # Array untuk menyimpan nilai Z_t untuk setiap bak
  Z_t <- numeric(num_bak)

  # Looping untuk setiap bak
  for (bak in 1:num_bak) {
    bak_mean <- mean(data_matrix[bak, , drop = FALSE]) # Menghitung rata-rata
dari bak ke-i
    if (bak == 1) {
      Z_t[bak] <- lambda * bak_mean + (1 - lambda) * mean_value
    } else {
      Z_t[bak] <- lambda * bak_mean + (1 - lambda) * Z_t[bak - 1]
    }

    # Simpan hasil UCL, LCL, CL, dan Z_t ke dalam data frame
    Nilai_REWMA_Biweight <- rbind(Nilai_REWMA_Biweight, data.frame(
      Lambda = lambda,
      UCL = control_limits$UCL,
      LCL = control_limits$LCL,
      CL = control_limits$CL,
      Z_t = Z_t[bak]
    ))
  }

  # Looping untuk setiap nilai k untuk menghitung ARL
  for (j in seq_along(k_values)) {
    k <- k_values[j]

    # Menghitung  $\beta$  menggunakan distribusi normal kumulatif (pnorm)
    beta <- pnorm((control_limits$UCL - (mean_value + k * mean_biweight)) /
(mean_biweight * sqrt(lambda / (2 - lambda)))) -
pnorm((control_limits$LCL - (mean_value + k * mean_biweight)) /
(mean_biweight * sqrt(lambda / (2 - lambda))))

    # Menghitung ARL berdasarkan  $\beta$ 

```

Lampiran 7. Perhitungan Nilai ARL REWMA dengan Estimator *Biweight* (Lanjutan)

```

    ARL_results[j, which(lambda_values == lambda)] <- 1 / (1 - beta)
  }
}

# Fungsi untuk menampilkan grafik peta kendali berdasarkan lambda
tampilkan_peta_kendali <- function(lambda) {
  # Filter data untuk lambda yang diinginkan
  data_lambda <- Nilai_REWMA_Biweight[Nilai_REWMA_Biweight$Lambda ==
lambda, ]

  # Periksa apakah lambda ada dalam dataset
  if (nrow(data_lambda) == 0) {
    cat("Tidak ada data untuk lambda =", lambda, "\n")
    return(NULL)
  }

  # Membuat grafik peta kendali dengan garis penghubung antar titik
  control_chart <- ggplot(data_lambda, aes(x = 1:nrow(data_lambda))) +
    geom_line(aes(y = Z_t, color = "Wi"), size = 1) + # Garis penghubung nilai Z_t
    geom_line(aes(y = UCL, color = "UCL"), size = 1, linetype = "dashed") + # Garis
UCL
    geom_line(aes(y = LCL, color = "LCL"), size = 1, linetype = "dashed") + # Garis
LCL
    geom_line(aes(y = CL, color = "CL"), size = 1, linetype = "solid") + # Garis CL
    geom_point(aes(y = Z_t, color = "Wi"), size = 3) + # Kembalikan ukuran bulatan
Z_t
    geom_point(aes(y = UCL, color = "UCL"), size = 3) + # Kembalikan ukuran
bulatan UCL
    geom_point(aes(y = LCL, color = "LCL"), size = 3) + # Kembalikan ukuran
bulatan LCL
    geom_point(aes(y = CL, color = "CL"), size = 3) + # Kembalikan ukuran bulatan
CL
    labs(title = paste("REWMA Biweight  $\lambda$  =", format(lambda, digits = 2,
decimal.mark = ",")),
         x = "Observasi", y = "Nilai") + # Tambahkan judul dengan format sesuai
lambda
    scale_color_manual(values = c("Wi" = "yellow", "UCL" = "blue", "LCL" =
"orange", "CL" = "grey")) +
    theme_minimal() +
    theme(
      text = element_text(family = "roboto"), # Gunakan font Roboto
      plot.title = element_text(size = 16, face = "bold", hjust = 0.5), # Ukuran title 16,
bold, dan center
      axis.text.x = element_text(size = 10), # Ukuran teks untuk sumbu x menjadi
10
      axis.text.y = element_text(size = 10), # Ukuran teks untuk sumbu y menjadi
10
      legend.position = "right", # Posisi legenda di kanan

```

Lampiran 7. Perhitungan Nilai ARL REWMA dengan Estimator *Biweight* (Lanjutan)

```

legend.title = element_blank(), # Hilangkan judul legenda
legend.text = element_text(size = 10), # Perkecil ukuran teks legenda menjadi
11
panel.border = element_rect(colour = "black", fill = NA, size = 1), # Tambah
garis pinggir hitam
plot.background = element_rect(colour = "black", fill = NA, size = 1) # Tambah
garis pinggir hitam
)

# Menampilkan grafik peta kendali
print(control_chart)
}

# Menambahkan kolom Status untuk memeriksa apakah Z_t berada di dalam atau
di luar batas kontrol
Nilai_REWMA_Biweight$Status <- ifelse(Nilai_REWMA_Biweight$Z_t >
Nilai_REWMA_Biweight$UCL, "Out of Control",
ifelse(Nilai_REWMA_Biweight$Z_t <
Nilai_REWMA_Biweight$LCL, "Out of Control",
"In Control"))

# Menghitung jumlah "Out of Control" untuk setiap nilai lambda
jumlah_out_of_control <- aggregate(Status ~ Lambda, data =
Nilai_REWMA_Biweight, function(x) sum(x == "Out of Control"))

# Konversi hasil ARL ke data frame
ARL_results_df_Biweight <- as.data.frame(ARL_results)

tampilkan_peta_kendali(0.01)

```