DAFTAR PUSTAKA

Abiyyu, I. (2015). *Proyeksi Cadangan Klaim dengan Metode Munich Chain Ladder.* Institut Pertanian Bogor.

Adam, F. F. (2017). Claim Reserving Estimation by Using the Chain Ladder Method. *KnE Social Sciences*, 1192-1204. doi:10.18502/kss.v3i11.2840

Adijuwono, E. F. (2016). *Estimasi Cadangan Klaim Pada Asuransi Kendaraan Bermotor Menggunakan Model Munich Chain Ladder.* Universitas Indonesia.

Badruzaman, D. (2019). Amwaluna : Perlindungan Hukum Tertanggung Dalam Pembayaran Klaim Asuransi Jiwa. *Jurnal Ekonomi dan Keuangan Syariah, 3*(1), 91-114. doi:10.29313/amwaluna.v3i1.4217

Chadick, C., Campbell, W., & Knox-Seith, F. (2009). *Comparison of Incurred but not Reported (IBNR) Method.* Society of Actuaries.

Cipra, T. (2010). *Financial and Insurance Formulas.* Jerman: Physica-Verlag HD.

Friedland, J. (2010). *Estimating Unpaid Claims Using Basic Techniques.* Casualty Actuarial Society.

Guntara, D. (2016). Asuransi dan Ketentuan-ketentuan Hukum yang Mengaturnya. *Justisi: Jurnal Ilmu Hukum, 1*(1), 29-46. doi:10.36805/jjih.v1i1.79

Hikmah, Y., & Hikmah, I. R. (2022). Perhitungan Klaim dengan Metode Chain Ladder Menggunakan Excel dan RStudio. *Mathematics & Applications Journal*, 122-131.

ILO. ( ). *International Labour Organization : Occupational Healthy and Safe*. Dipetik November 29, 2023, dari International Labour Organization: https://www.ilo.org

Lewis, C. D. (1982). *Industrial and Business Forecasting Methods: A Practical Guide to Exponential Smoothing and Curve Fitting.* Butterworth Scientific.

OSHA. (t.thn.). *Occupational Safety and Health Administration : Business Case for Safety and Health*. Dipetik November 29, 2023, dari Occupational Safety and Health Administration: https://www.osha.gov/

Prajitno, B. B. (2021). *Penerapan Metode Cape Cod dalam Prediksi Cadangan Klaim Incurred But not Reported (IBNR) Dalam Asuransi Jiwa (Studi Kasus Asuransi Jiwa ABC)".* Tesis, Fakultas Ekonomi dan Bisnis, Universitas Indonesia.

., & Mack, T. (2008). Munich Chain Ladder: A Reserving Method that educes the Gap between IBNR Projections Based on Paid Losses and

IBNR Projections Based on Incurred Losses. *Casualty Actuarial Society, 2*(2), 266-299. doi:10.1007/bf02808969

Radtke, M., & Schmidt, K. D. (2016). *Handbook on Loss Reserving.* Jerman: Springer International Publishing.

Riyadi, A. A. (2022). *Analisis Estimasi Cadangan Klaim IBNR Pada Asuransi Kredit Menggunakan Metode Munich Chain Ladder dan Bornhuetter-Ferguson Pada PT XYZ.* Tesis, Fakultas Ekonomi dan Bisnis, Universitas Indonesia, Depok.

Rusdy, A., Purnawansyah, & Herman. (2022). Penerapan Metode Regresi Linear pada Prediksi Penawaran dan Permintaan Obat Studi Kasus Aplikasi Point of Sales. *Buletin Sistem Informasi dan Teknologi Islam, 3*(2), 121-126.

Saluz, A. (2015). Prediction Uncertainties in The Cape Cod Reserving Method. *Annals of Actuarial Science, 9*(2), 239-263. doi:10.1017/S1748499514000359

The Secret of Wealth Management. (2013). *Cara Membangun Kekayaan Mulai Dari Nol.* Surabaya: MIC Publishing.

Wilkinson, C. (2010). *Insurance Handbook : A Guidance to Insurance What It does and How It Works.* New York.

Wüthrich, M. V., & Merz, M. (2008). *Stochastic Claims Reserving Methods in Insurance.* England: John Wiley & Sons.

Lampiran 1. *Run-off triangle incremental* klaim dibayar (*paid*)

Periode Kejadian (*i*)	*Development Period* (*s*)									
	1	2	3	4	5	6	7	8	9	10
2013	294.783	376.236	226.779	156.549	92.521	64.255	40.171	31.400	32.949	25.031
2014	281.771	359.979	205.579	130.251	90.709	50.333	38.844	29.247	27.309	-
2015	296.958	418.060	236.834	157.743	88.525	60.171	49.058	33.852	-	-
2016	322.635	442.723	254.337	159.582	85.197	63.641	49.061	-	-	-
2017	335.185	468.077	255.921	148.504	90.782	66.876	-	-	-	-
2018	344.061	499.783	260.228	158.177	102.651	-	-	-	-	-
2019	359.502	458.650	253.645	169.571	-	-	-	-	-	-
2020	272.709	377.283	205.884	-	-	-	-	-	-	-
2021	311.400	441.873	-	-	-	-	-	-	-	-
2022	335.445	-	-	-	-	-	-	-	-	-

Lampiran 2. *Run-off triangle incremental* klaim dilaporkan (*incurred*)

Periode Kejadian (*i*)	*Development Period* (*s*)									
	1	2	3	4	5	6	7	8	9	10
2013	696.769	361.073	184.095	117.197	62.015	34.526	23.489	14.119	8.805	6.714
2014	607.519	359.194	172.765	99.139	56.851	14.257	25.999	20.177	14.687	-
2015	664.935	417.555	196.156	105.434	57.976	28.350	19.670	19.685	-	-
2016	777.074	425.129	186.160	66.177	56.722	36.413	27.833	-	-	-
2017	735.383	453.391	215.789	100.914	45.228	34.956	-	-	-	-
2018	787.600	478.602	199.368	107.937	60.661	-	-	-	-	-
2019	804.095	429.424	163.683	131.028	-	-	-	-	-	-
2020	640.074	346.007	163.590	-	-	-	-	-	-	-
1	753.048	429.446	-	-	-	-	-	-	-	-
2	808.419	-	-	-	-	-	-	-	-	-

Lampiran 3. Hasil estimasi *development factor* dan parameter σ

Parameter	*Development Period (s)*								
	1 → 2	**2 → 3**	**3 → 4**	**4 → 5**	**5 → 6**	**6 → 7**	**7 → 8**	**8 → 9**	**9→ 10**
$\widehat{f}^{P}_{s\to t}$	2,3631	1,3214	1,1554	1,0810	1,0511	1,0360	1,0254	1,0244	1,0190
$\widehat{f}^{I}_{s\to t}$	1,5722	1,1649	1,0781	1,0399	1,0206	1,0168	1,0125	1,0082	1,0045
$\sigma^{P}_{s\to t}$	38,4995	9,3668	11,8578	7,9644	3,4162	2,8245	0,4759	2,1004	1,0000
$\sigma^{I}_{s\to t}$	33,6509	18,3648	18,9587	6,9995	6,4077	3,2772	3,3710	4,1603	1,0000

Lampiran 4. Hasil estimasi pola rasio (P/I), rasio (I/P) dan parameter ρ

Parameter	*Development Period (s)*									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
$\hat{q}_s$	0,4336	0,6553	0,7460	0,7997	0,8291	0,8524	0,8661	0,8742	0,8806	0,8886
$\hat{q}_s{}^{-1}$	2,3062	1,5261	1,3404	1,2504	1,2062	1,1732	1,1546	1,1439	1,1356	1,1254
$\widehat{\rho}^{I}_{s}$	15,4403	16,2971	15,3683	15,0527	13,9867	14,1034	17,2388	18,0273	8,3736	
$\widehat{\rho}^{P}_{s}$	53,8275	30,8611	23,8893	21,1999	18,6860	18,0695	21,5182	22,0777	10,1308	

Lampiran 5. Hasil estimasi *triangle residual* $\widehat{Res}(P_{i,t})$

P	*Development Period*								
	1 → 2	**2 → 3**	**3 → 4**	**4 → 5**	**5 → 6**	**6 → 7**	**7 → 8**	**8 → 9**	**9 → 10**
1	(1,2243)	1,4447	1,5149	0,8641	1,5501	(1,1154)	(0,7889)	0,6932	-
2	(1,1798)	(0,0942)	(0,1314)	1,4575	(1,2000)	(0,4892)	(0,3652)	(0,7207)	-
3	0,6325	0,8834	0,8484	(0,1677)	(0,2757)	1,1743	1,1154	-	-
4	0,1340	1,0151	0,0927	(1,2005)	(0,2475)	0,3710	-	-	-
5	0,5015	(0,2717)	(1,3197)	(0,8113)	0,1408	-	-	-	-
6	1,3631	(1,2807)	(1,0761)	0,0387	-	-	-	-	-
7	(1,3602)	(1,1027)	0,2445	-	-	-	-	-	-
8	0,2758	(0,4039)	-	-	-	-	-	-	-
9	0,8096	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-

Lampiran 6. Hasil estimasi *triangle residual* $\widehat{Res}(I_{i,t})$

I	*Development Period*								
	1 → 2	**2 → 3**	**3 → 4**	**4 → 5**	**5 → 6**	**6 → 7**	**7 → 8**	**8 → 9**	**9 → 10**
1	(1,3381)	0,5102	0,9545	0,9601	0,6936	(0,2334)	(1,0802)	(0,6898)	-
2	0,4423	0,7385	0,4997	0,9596	(1,6984)	1,0757	0,8798	0,7240	-
3	1,3524	0,9228	0,2582	0,3402	(0,1700)	(1,2555)	0,2433	-	-
4	(0,6565)	(0,6012)	(1,8933)	(0,1494)	0,6769	0,4606	-	-	-
5	1,1311	0,9857	(0,3926)	(1,7216)	0,3840	-	-	-	-
6	0,9367	(0,4575)	(0,2861)	(0,2352)	-	-	-	-	-
7	(1,0154)	(1,9487)	0,9758	-	-	-	-	-	-
8	(0,7508)	0,0530	-	-	-	-	-	-	-
	(0,0483)	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-

Lampiran 7. Hasil estimasi *triangle residual* $\widehat{Res}(Q_{i,s})$

$(Q_{i,s})$	*Development Period*									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	(0,5695)	(1,3215)	(1,6777)	(1,8569)	(1,8797)	(1,7455)	(1,4243)	(1,0323)	(0,6907)	-
2	1,5245	0,5176	(0,1685)	(0,7744)	(0,3596)	0,1366	0,0275	0,0657	0,7231	-
3	0,6860	0,3359	(0,1189)	0,1532	0,1535	0,2871	0,7956	0,9644	-	-
4	(1,0513)	(1,2540)	(0,8877)	0,8838	0,6720	0,5054	0,5810	-	-	-
5	1,2324	1,3673	0,6219	0,2014	0,7377	0,7725	-	-	-	-
6	0,1863	0,7711	0,5752	0,2053	0,5640	-	-	-	-	-
7	0,7830	0,5451	1,6202	1,0320	-	-	-	-	-	-
8	(0,3911)	0,2375	(0,1105)	-	-	-	-	-	-	-
9	(1,1289)	(1,2176)	-	-	-	-	-	-	-	-
10	(1,0870)	-	-	-	-	-	-	-	-	-

Lampiran 8. Hasil estimasi *triangle residual* $\widehat{Res}(Q_{i,s}^{-1})$

$(Q_{i,s}^{-1})$	*Development Period*									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0,5793	1,3372	1,7015	1,8718	1,8891	1,7522	1,4323	1,0403	0,6928	-
2	(1,4809)	(0,5119)	0,1685	0,7739	0,3575	(0,1354)	(0,0273)	(0,0656)	(0,7212)	-
3	(0,6791)	(0,3331)	0,1188	(0,1519)	(0,1520)	(0,2842)	(0,7857)	(0,9557)	-	-
4	1,0793	1,2666	0,8932	(0,8715)	(0,6633)	(0,4996)	(0,5748)	-	-	-
5	(1,2076)	(1,3405)	(0,6175)	(0,1997)	(0,7279)	(0,7622)	-	-	-	-
6	(0,1865)	(0,7613)	(0,5715)	(0,2035)	(0,5572)	-	-	-	-	-
7	(0,7747)	(0,5394)	(1,5951)	(1,0167)	-	-	-	-	-	-
8	0,3964	(0,2358)	0,1104	-	-	-	-	-	-	-
	1614	1,2295	-	-	-	-	-	-	-	-
	1163	-	-	-	-	-	-	-	-	-

Lampiran 9. Hasil perhitungan $\widehat{Res}\left(Q_{i,s}^{-1}\right)\widehat{Res}\left(P_{i,t}\right)$

	1	2	3	4	5	6	7	8	9
1	(0,7092)	1,9319	2,5776	1,6175	2,9283	(1,9544)	(1,1300)	0,7212	-
2	1,7471	0,0482	(0,0221)	1,1280	(0,4291)	0,0662	0,0100	0,0473	-
3	(0,4295)	(0,2943)	0,1008	0,0255	0,0419	(0,3337)	(0,8764)	-	-
4	0,1446	1,2857	0,0828	1,0462	0,1642	(0,1853)	-	-	-
5	(0,6056)	0,3642	0,8149	0,1620	(0,1025)	-	-	-	-
6	(0,2542)	0,9749	0,6150	(0,0079)	-	-	-	-	-
7	1,0537	0,5948	(0,3900)	-	-	-	-	-	-
8	0,1093	0,0952	-	-	-	-	-	-	-
9	0,9403	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-
	Total								**13,7153**

Lampiran 10. Hasil perhitungan $\widehat{Res}\left(Q_{i,s}^{-1}\right)^2$

	1	2	3	4	5	6	7	8	9
1	0,3355	1,7881	2,8951	3,5036	3,5688	3,0703	2,0516	1,0823	0,4799
2	2,1930	0,2621	0,0284	0,5989	0,1278	0,0183	0,0007	0,0043	0,5201
3	0,4612	0,1110	0,0141	0,0231	0,0231	0,0808	0,6173	0,9134	-
4	1,1649	1,6042	0,7979	0,7595	0,4399	0,2496	0,3304	-	-
5	1,4583	1,7970	0,3813	0,0399	0,5298	0,5810	-	-	-
6	0,0348	0,5795	0,3266	0,0414	0,3105	-	-	-	-
7	0,6002	0,2909	2,5445	1,0336	-	-	-	-	-
8	0,1571	0,0556	0,0122	-	-	-	-	-	-
	1,3488	1,5116	-	-	-	-	-	-	-
	1,2462	-	-	-	-	-	-	-	-
	Total								**45**

Lampiran 11. Hasil perhitungan $\widehat{Res}(Q_{i,s})\widehat{Res}(I_{i,t})$

	1	2	3	4	5	6	7	8	9
1	0,7621	(0,6742)	(1,6013)	(1,7828)	(1,3038)	0,4074	1,5385	0,7121	-
2	0,6743	0,3822	(0,0842)	(0,7431)	0,6107	0,1470	0,0242	0,0475	-
3	0,9278	0,3100	(0,0307)	0,0521	(0,0261)	(0,3605)	0,1935	-	-
4	0,6902	0,7539	1,6807	(0,1321)	0,4549	0,2328	-	-	-
5	1,3939	1,3478	(0,2442)	(0,3468)	0,2833	-	-	-	-
6	0,1745	(0,3528)	(0,1645)	(0,0483)	-	-	-	-	-
7	(0,7951)	(1,0622)	1,5809	-	-	-	-	-	-
8	0,2936	0,0126	-	-	-	-	-	-	-
9	0,0546	-	-	-	-	-	-	-	-
10		-	-	-	-	-	-	-	-
	Total								**5,9908**

Lampiran 12. Hasil perhitungan $\widehat{Res}(Q_{i,s})^2$

	1	2	3	4	5	6	7	8	9
1	0,3244	1,7464	2,8146	3,4479	3,5332	3,0468	2,0287	1,0656	0,4771
2	2,3241	0,2679	0,0284	0,5997	0,1293	0,0187	0,0008	0,0043	0,5229
3	0,4706	0,1129	0,0141	0,0235	0,0235	0,0824	0,6330	0,9301	-
4	1,1052	1,5725	0,7881	0,7812	0,4516	0,2554	0,3376	-	-
5	1,5189	1,8696	0,3867	0,0406	0,5442	0,5967	-	-	-
6	0,0347	0,5947	0,3308	0,0421	0,3181	-	-	-	-
7	0,6131	0,2971	2,6250	1,0651	-	-	-	-	-
8	0,1529	0,0564	0,0122	-	-	-	-	-	-
9	1,2745	1,4826	-	-	-	-	-	-	-
	1,1816	-	-	-	-	-	-	-	-
	tal								**45**

Lampiran 13. Segitiga *development factor* klaim dibayar (*paid*)

P	*Development Period*									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	1,0188
3	-	-	-	-	-	-	-	-	1,0239	1,0182
4	-	-	-	-	-	-	-	1,0254	1,0240	1,0183
5	-	-	-	-	-	-	1,0355	1,0253	1,0239	1,0183
6	-	-	-	-	-	1,0506	1,0356	1,0253	1,0240	1,0183
7	-	-	-	-	1,0788	1,0500	1,0352	1,0253	1,0237	1,0181
8	-	-	-	1,1558	1,0813	1,0510	1,0359	1,0254	1,0241	1,0185
9	-	-	1,3255	1,1609	1,0838	1,0519	1,0366	1,0255	1,0245	1,0188
10	-	2,3857	1,3267	1,1622	1,0845	1,0522	1,0368	1,0255	1,0246	1,0189

Lampiran 14. Segitiga *development factor* klaim dilaporkan (*incurred*)

I	*Development Period*									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	1,0046
3	-	-	-	-	-	-	-	-	1,0087	1,0048
4	-	-	-	-	-	-	-	1,0127	1,0086	1,0048
5	-	-	-	-	-	-	1,0170	1,0128	1,0087	1,0048
6	-	-	-	-	-	1,0209	1,0170	1,0128	1,0086	1,0048
7	-	-	-	-	1,0406	1,0214	1,0172	1,0129	1,0088	1,0049
8	-	-	-	1,0779	1,0398	1,0206	1,0168	1,0127	1,0085	1,0047
	-	-	1,1622	1,0749	1,0389	1,0199	1,0165	1,0124	1,0082	1,0046
	-	1,5667	1,1614	1,0741	1,0387	1,0197	1,0164	1,0123	1,0081	1,0045

Lampiran 15. Hasil proyeksi kumulatif klaim dibayar

P	Development Period									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	294.783	671.019	897.798	1.054.347	1.146.868	1.211.124	1.251.295	1.282.694	1.315.644	1.340.675
2	281.771	641.750	847.329	977.580	1.068.289	1.118.622	1.157.466	1.186.713	1.214.022	1.236.878
3	296.958	715.018	951.851	1.109.595	1.198.120	1.258.292	1.307.350	1.341.202	1.373.221	1.398.248
4	322.635	765.358	1.019.695	1.179.277	1.264.473	1.328.114	1.377.176	1.412.098	1.445.985	1.472.510
5	335.185	803.262	1.059.183	1.207.687	1.298.469	1.365.345	1.413.774	1.449.593	1.484.245	1.511.341
6	344.061	843.844	1.104.072	1.262.249	1.364.900	1.433.944	1.484.951	1.522.593	1.559.072	1.587.614
7	359.502	818.151	1.071.797	1.241.367	1.339.230	1.406.245	1.455.703	1.492.528	1.527.971	1.555.633
8	272.709	649.992	855.876	989.259	1.069.689	1.124.232	1.164.557	1.194.122	1.222.919	1.245.491
9	311.400	753.273	998.452	1.159.059	1.256.197	1.321.454	1.369.785	1.404.683	1.439.079	1.466.154
10	335.445	800.286	1.061.719	1.233.964	1.338.223	1.408.090	1.459.860	1.497.088	1.533.898	1.562.905

Lampiran 16. Nilai MAPE untuk metode *munich chain ladder*

Periode	Nilai Ultimate Aktual (y_t)	Nilai Ultimate Prediksi ($\hat{y}_t$)	$\left\|\frac{y_t - \hat{y}_t}{y_t}\right\|$
1	1.778.911	1.508.802	0,1518
2	1.675.051	1.376.826	0,1780
3	1.865.787	1.530.184	0,1799
4	1.971.178	1.616.928	0,1797
5	2.020.760	1.655.372	0,1808
6	2.130.826	1.741.474	0,1827
7	2.094.388	1.696.489	0,1900
8	1.771.229	1.372.070	0,2254
9	2.089.313	1.631.484	0,2191
10	2.028.276	1.743.868	0,1402
Nilai MAPE			**18,28%**

Lampiran 17. Nilai MAPE untuk metode *cape cod*

Periode	Nilai Ultimate Aktual (y_t)	Nilai Ultimate Prediksi ($\hat{y}_t$)	$\left\|\frac{y_t - \hat{y}_t}{y_t}\right\|$
1	1.778.911	1.508.802	0,1518
2	1.675.051	1.377.274	0,1778
3	1.865.787	1.530.483	0,1797
4	1.971.178	1.617.918	0,1792
5	2.020.760	1.655.473	0,1808
6	2.130.826	1.734.362	0,1861
7	2.094.388	1.680.779	0,1975
8	1.771.229	1.382.069	0,2197
9	2.089.313	1.602.493	0,2330
10	2.028.276	1.644.838	0,1890
Nilai MAPE			**18,95%**