









No	Policy Holder	$A_{xy:\overline{n}}$	
		TMI 2011	Mortality Table Gompertz assumption
1	Justin & Selena	122,057,532	122,481,303
2	Adam & Behati	122,058,468	122,587,748
3	Zayn & Gigi	122,075,101	123,083,083
4	Alif & Nada	122,091,221	123,328,116
5	Morgan & Bella	122,145,678	123,740,434

Calculate the Annual Net Premium of Last Survivor Endowment Life Insurance, Calculation of the annual net premium denoted can be calculated using equation (3), based on Table 1 and Table 2, the 1st annual policy premium obtained by the policyholder is based on TMI 2011 as follows:

$$P_{\overline{20,22}:\overline{20}} = \frac{A_{\overline{20,22}:\overline{20}}}{\ddot{a}_{\overline{20,22}:\overline{20}}} = 7,639,001$$

By using the same method, the annual net premium of endowment survivor life insurance can be calculated for other policy holders, so that it can be written in Table3.

Table 3. Annual Net Insurance Premium for Last Survivor Endowment Life Insurance

No	Policy Holder	$P_{xy:\overline{n}}$	
		TMI 2011	Mortality Table Gompertz assumption
1	Justin & Selena	7,639,001	7,707,428
2	Adam & Behati	7,639,151	7,724,733
3	Zayn & Gigi	7,641,823	7,805,894
4	Alif & Nada	7,644,414	7,846,430
5	Morgan & Bella	7,653,173	7,915,228

Calculate adjusted premium reserves based on the 2011 Indonesian Mortality Table (TMI) and the Gompertz Assumption Mortality Table. First, the premium value for the first year ( $\alpha$ ) and the next year premium ( $\beta$ ) will be calculated using the Full Preliminary Term valuation in equations (4) and (5). The calculation for the 1<sup>st</sup> policy holder is based on the 2011 Indonesian Mortality Table (TMI), namely:

$$\alpha = (2 \cdot 10^8) \frac{C_{20,22}}{D_{20,22}} = 159,657 \quad \beta = P + \frac{P-\alpha}{a_{20,22:\overline{19}}} = 8,118,805$$

Using the same method, values ( $\alpha$ ) and ( $\beta$ ) can be calculated for each policyholder and can be written in Table 4.

Table 4. First year premium ( $\alpha$ ) and next year premium ( $\beta$ )

No	Policy Holder	$\alpha$		$\beta$	
		TMI 2011	Mortality Table Gompertz assumption	TMI 2011	Mortality Table Gompertz assumption
1	Justin & Selena	159,657	2,200,891	8,118,805	8,062,992
2	Adam & Behati	225,847	2,481,522	8,114,726	8,063,850
3	Zayn & Gigi	297,851	3,516,415	8,113,084	8,085,455
4	Alif & Nada	383,457	3,956,015	8,110,473	8,100,944
5	Morgan & Bella	673,443	4,589,953	8,101,579	8,134,165

After obtaining a value ( $\alpha$ ) and ( $\beta$ ) from each policy holder, then the premium reserves can be calculated adjusted for End Survivor Endowment life insurance products, with compensation for both policyholders of Rp200,000,000.00 with a 20 years coverage period Premium reserves are calculated using the retrospective method based on equations (13) and (15), for the first policy holder of the large premium reserves adjusted in the first year based on the 2011 Indonesian Mortality Table (TMI) as follows:

$${}_1V_{20,22} = (\alpha)u_{20,22} - (B(k_{20,22})) = (\alpha) \frac{D_{20+1-1,22+1-1}}{D_{20+1,22+1}} - \left( B \left( \frac{C_{20+1-1,22+1-1}}{D_{20+1,22+1}} \right) \right) = 0$$

The adjusted premium premium for the 2<sup>nd</sup> year is as follows:  ${}_2V_{20,22} = ({}_{2-1}V + \beta)u_{20+2-1,22+2-1} - (B(k_{20+2-1,22+2-1})) = ({}_{2-1}V + \beta) \frac{D_{20+2-1,22+2-1}}{D_{20+2,22+2}} - \left( B \left( \frac{C_{20+2-1,22+2-1}}{D_{20+2,22+2}} \right) \right) = 8,153,882$

Using the same method, we can calculate the adjusted premium reserve. Using the Gompertz Assumption Mortality Table for other policyholders, Table 5 to Table 9 can be formed which contains the amount of premium reserves adjusted for each policy holder from the first year to the end of the policy year.

Table 5. Reserve of premium for the 1-st policyholder

T	TMI 2011 (Rupiah)	Mortality Table for Gompertz (Rupiah)
1	0	0
2	8,153,882	6,000,449
3	16,513,934	12,146,811
4	25,089,736	18,447,371
5	33,894,277	24,911,206
6	42,941,750	31,548,277
7	52,245,691	38,369,515
8	61,814,752	45,386,933
9	71,656,251	52,613,741
10	81,774,156	60,064,484
11	92,173,476	67,755,182
12	102,862,285	75,703,506
13	113,850,986	83,928,964
14	125,149,993	92,453,112
15	136,765,921	101,299,800
16	148,706,890	110,495,439
17	160,985,116	120,069,313
18	173,613,553	130,053,931
19	186,607,812	140,485,424
20	199,984,194	151,404,003

Table 6. Reserve of premium for the 2-nd policyholder

T	TMI 2011 (Rupiah)	Mortality Table for Gompertz (Rupiah)
1	0	0
2	8,111,289	5,706,765
3	16,454,930	11,545,140
4	25,030,127	17,523,025
5	33,840,428	23,649,125
6	42,890,043	29,933,041
7	52,188,324	36,385,367
8	61,744,647	43,017,807
9	71,565,828	49,843,296
10	81,656,843	56,876,147
11	92,023,784	64,132,209
12	102,675,891	71,629,048
13	113,623,097	79,386,154
14	124,873,056	87,425,172
15	136,434,231	95,770,166
16	148,317,998	104,447,924
17	160,542,448	113,488,296
18	173,124,170	122,924,587
19	186,082,282	132,794,006
20	199,438,054	143,138,183

Table 7. Reserve premium for 3<sup>th</sup> policyholder

T	TMI 2011 (Rupiah)	Mortality Table for Gompertz (Rupiah)
---	-------------------	---------------------------------------

Tabel 8. Reserve premium for 4<sup>th</sup> policyholder

T	TMI 2011 (Rupiah)	Mortality Table for Gompertz (Rupiah)
---	-------------------	---------------------------------------

1	0	0
2	8,013,559	4,672,248
3	16,231,410	9,454,809
4	24,656,515	14,355,650
5	33,292,787	19,383,719
6	42,141,997	24,549,067
7	51,210,452	29,862,992
8	60,502,851	35,338,207
9	70,028,258	40,989,022
10	79,791,107	46,831,568
11	89,801,947	52,884,041
12	100,070,539	59,166,992
13	110,608,982	65,703,656
14	121,433,965	72,520,336
15	132,564,640	79,646,848
16	144,024,404	87,117,042
17	155,842,704	94,969,398
18	168,056,409	103,247,736
19	180,706,575	112,002,042
20	193,840,355	121,289,429

1	0	0
2	7,926,305	4,237,526
3	16,052,433	8,574,325
4	24,378,260	13,017,958
5	32,908,387	17,576,992
6	41,648,481	22,261,133
7	50,603,847	27,081,392
8	59,775,620	32,050,266
9	69,168,755	37,181,949
10	78,791,876	42,492,578
11	88,659,336	48,000,521
12	98,783,207	53,726,704
13	109,174,036	59,694,998
14	119,844,685	65,932,672
15	130,816,159	72,470,919
16	142,117,466	79,345,477
17	153,784,864	86,597,357
18	165,859,355	94,273,704
19	178,383,881	102,428,817
20	191,406,303	111,125,355

Table 9. Reserve premium for 5<sup>th</sup> policyholder

t	TMI 2011 (Rupiah)	Mortality Table for Gompertz (Rupiah)
1	0	0
2	7,566,434	3,638,267
3	15,265,851	7,378,152
4	23,102,159	11,228,328
5	31,075,752	15,198,747
6	39,187,608	19,300,838
7	47,436,682	23,547,745
8	55,828,172	27,954,592
9	64,379,993	32,538,811
10	73,111,993	37,320,510
11	82,047,352	42,322,924
12	91,209,195	47,572,934
13	10,622,473	53,101,695
14	110,317,322	58,945,368
15	120,327,875	65,146,008
16	130,686,653	71,752,613
17	141,428,923	78,822,390
18	152,594,068	86,422,270
19	164,231,971	94,630,741
20	176,406,736	103,540,059

#### 4. Conclusions

Based on the results of the discussion that has been done, it can be concluded several things. First, the results of calculations in determining the last survivor endowment life insurance premiums based on the 2011 Indonesian Mortality Table (TMI) are smaller than those based on the Gompertz Assumption Mortality Table. So that the determination of premiums is better with the 2011 Indonesian Mortality Table (TMI). Second, the results of the calculation of adjusted premium reserves for last survivor endowment life insurance products using the 2011 Indonesian Mortality Table (TMI) are closer to the benefits to be provided compared to the Gompertz Assumption Mortality Table. Furthermore, adjusted premium reserves for end survivor last survivor life insurance products using the 2011 Mortality Table of Indonesia (TMI) is greater than the Gompertz Assumption Mortality Table, so that the use of Gompertz assumptions is not good for insurance companies.

## **Acknowledgements**

The Authors would like to thank to Universitas Padjadjaran, who gave funding for the RDDU research and preparation of this paper.

## **References**

- Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., Nesbit, C. J. 1997. Actuarial Mathematics. The Society of Actuaries, United States of America.
- Dey, S., Moala, F. A., & Kumar, D. 2018. Statistical Properties and Different Methods of Estimation of Gompertz Distribution with Application. *Journal of Statistics and Management Systems*, 21(5): 839–876. <https://doi.org/10.1080/09720510.2018.1450197>.
- Frostig, E. B. L. 2003. The Impact of Statistical Dependence on Multiple Life Insurance Program. *Departement of Statistics, University of Haifa*.
- Futami, T. 1993. *Oriental Life Insurance Cultural Development Center, Inc. Tokyo. Japan*.
- Futami, T. 1994. *Oriental Life Insurance Cultural Development Center, Inc. Tokyo. Japan*.
- Fiyan Handoyo<sup>1,\*</sup>, Riaman<sup>2</sup>, Nurul Gusriani<sup>2</sup>, Sudrajat Supian<sup>2</sup>, Subiyanto<sup>3</sup>, 2019, Joint Life Term Insurance Reserves Use the Retrospective Method Based on De Moivre Law, Available online at [www.worldscientificnews.com](http://www.worldscientificnews.com) (Received 22 April 2019; Accepted 08 May 2019; Date of Publication 09 May 2019)
- Ghufron. 2014. Prospective Reserve of Last Survivor with Gompertz Assumptions. *JOM FMIPA October 2014,1(2): 466-474*.
- Larson, R. E., & Gaumnitz, E. A. 1962. *Life Insurance Mathematics (Fourth ed.)*. New York: John Wiley and Sons Inc.
- Promislow, S. David. 2011. *Fundamental of Actuarial Mathematics (Second ed.)*. United Kingdom: John Wiley and Sons Inc.
- Ramadani, D. 2014. Prospective Reserves for Life Insurance with De Moivre Law. *Journal of Online Students (JOM) FMIPA February 2014, 1 (2): 1-7*.
- Valdez, E. A., Vadiveloo, J., Dias, U., 2014. Life Insurance Policy Termination and Survivorship. *Insurance: Mathematics and Economics*, 58: 138-149. <http://dx.doi.org/10.1016/j.insmatheco.2014.06.011>.
- Willemse, W. J. & H. Koppelaar. 2000. Knowledge Elicitation of Gompertz Law of Mortality. *Scandinavian Actuarial Journal*, 2: 168-179. <https://doi.org/10.1080/034612300750066845>.

## **Biography / Biographies**

**Riaman** is a teaching staff in the mathematics study program at the Mathematics Department of the University of Padjadjaran since 1997. The mathematics degree was won from the Mathematics Department of the University of Padjadjaran in 1995, while the Masters of Actuarial Science was obtained from the Bandung Institute of Technology in 2000. The field of research currently being undertaken is the field of applied mathematics. More specifically are: fields of financial mathematics, actuarial mathematics, survival models, mathematical statistics, and reliability. Since 2001 until now he has joined as a member of IndoMS, and since 2017 joined IAENG.



**Sukono** is a lecturer in the Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Currently serves as Head of Master's Program in Mathematics, the field of applied mathematics, with a field of concentration of financial mathematics and actuarial sciences.

**Sudradjat Supian** is a Professor of Operation Research in the Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Currently serves as dean of Faculty of Mathematics and Natural Sciences, the field of applied mathematics, with a field of operation research and modeling.

**Abdul Talib Bon** is a professor of Production and Operations Management in the Faculty of Technology Management and Business at the Universiti Tun Hussein Onn Malaysia since 1999. He has a PhD in Computer Science, which he obtained from the Universite de La Rochelle, France in the year 2008. His doctoral thesis was on topic Process Quality Improvement on Beltline Moulding Manufacturing. He studied Business Administration in the Universiti Kebangsaan Malaysia for which he was awarded the MBA in the year 1998. He's bachelor degree and diploma in Mechanical Engineering which his obtained from the Universiti Teknologi Malaysia. He received his postgraduate certificate in Mechatronics and Robotics from Carlisle, United Kingdom in 1997. He had published more 150 International Proceedings and International Journals and 8 books. He is a member of MSORSM, IIF, IEOM, IIE, INFORMS, TAM and MIM.