



Estimation of Indonesian Male Life Table with Survivorship Probability Method in Smoothed Way by using Coale-Demeny's Life Table

Hanifah Dara Puspita¹, Nurul Huda Prasetya², Ismail Husein³,

^{1,2,3}Department of Mathematics, Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

Article Info

Article history:

Keywords:

Life table estimation,
Indonesian male population,
Survivorship probabilities,
Coale-Demeny West model life
table.

ABSTRACT

The population of Indonesia in each province are continuing increased every year. The total population of Indonesia in 2010 was 237.641.326, while in 2010 it increased by 32.562.591 people to 270.203.917 people, with the male population are greater than women population. By the population of Open Unemployment Male Rate (TPT) is higher than female, which is 5.31 percent compared to 5.23 percent. Unemployment is one of the ten important events in triggering stress. The male who don't have a job get a higher stress level then female, it found that the male who were unemployed were more risk towards death than female, about 78 percent compared to 37 percent. The purpose of this study is to estimate the life table of Indonesian male population by smoothing it using the Coale-Demeny's life table based on the 2010 and 2020 Population Census data. The method of this study is Survival Analysis in Smoothed Way by using Coale-Demeny's Life Table. The result of this study obtained by 58,84 years life expectancy (AHH), means that from 100.000 babies born will be able to live to the age of 58 or 59 years. By the pattern of the number of Indonesian male residents who survive, the result is close to (has similarities) to the pattern of the number of Indonesian male residents who survive that produced by the Central Statistics Agency (BPS-Statistics Indonesia).

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Hanifah Dara Puspita,
Department of Mathematics,
Universitas Islam Negeri Sumatera Utara, Medan, Indonesia
Email: hanifahdarapuspita870@gmail.com

1. INTRODUCTION

The population of Indonesia in each province continues to increase every year. The total population of Indonesia in 2010 was 237,641,326 people, while in 2010 it increased by 32,562,591 people to 270,203,917 people, with a male population of 119,630,913 people and a female population of 118,010,413 people. In the last ten years (2010-2020) Indonesia's population growth rate was 1.25 percent per year. There is a slowdown in the population growth rate of 0.24 percent when compared to the population growth rate in the 2000-2010 period which was 1.49 percent. The growth and uneven distribution of population in every province is a source of problems in Indonesia, one of which is unemployment. The open unemployment rate (TPT) is higher than female, which is 5.31 percent compared to 5.23 percent. Unemployment is one of the ten important events in triggering stress. (Spurgeon, et al., 2001). In a study by a sociology professor at Mc.Gill University in Montreal, showing that the male who don't have a job get a higher stress level then female, it found that the male who were unemployed were more risk towards death than female, about 78 percent compared to 37 percent.

Mortality is one of the components in demographics that can affect population change. The death of a person in a population can be caused by various factors, such as the structure of age, gender, type of work, socioeconomic status and the environmental conditions in which they are located can affect the low mortality rate (Wirosuhardjo, 1980). Mortality data are generally presented in the form of a life table, a means of presenting information about the probability of survival and mortality at some time, and in such a way that conclusions about the likelihood of death and survival can be drawn easily (Keyfitz, 1968).

The methods described in this study are all based on the same, very simple information, namely, the change in size of successive age cohorts of a population from one census to the next. The methods differ only in the way in which this basic information is smoothed to reduce the effects of errors and converted into a mortality parameter. The data required for this method are two census enumerations with the populations classified by age and sex. Although ω , the highest age reached, is the theoretical limit for the value of the intercensal interval t (measured in years), in practice, with intervals longer than 15 years the information available is scanty and the calculations are more likely to be affected by changes other than those caused by mortality. If t is divisible by five, both age distributions can be classified by five-year age groups and cohorts from the first census can be identified at the second census; if t is not a multiple of five, it is convenient to have one of the age distributions by single year of age, so that comparable cohorts may be constructed (UN, 1983).

2. RESEARCH METHODE

2.1 Mortality

Mortality is one of the demographic components that determine the welfare of the population, and represents the quality of the population, and can influence population changes in an area. The death of a person in a population can be caused by various factors. The structure of their age, sex, type of work, socioeconomic status and the environmental conditions in which they are located can affect the level of mortality. Low mortality rates indicate the success of a region's development, especially in the health sector (Wirosuhardjo, 1980).

In general, mortality data is presented in the form of a life table, which is a means of presenting information about the probability of survival and mortality at some time interval, age, and in such a way that conclusions about the likelihood of death and survival can be easily drawn (Keyfitz, 1968).

2.2 Survivorship Probabilities Method

The methods described in this study are all based on the same, very simple information, namely, the change in size of successive age cohorts of a population from one census to the next. The methods differ only in the way in which this basic information is smoothed to reduce the effects of errors and converted into a mortality parameter.

2.2.1 Smoothed Using The Coale-Demeny Life Tables

The steps of the computational procedures are described below.

1. Adjustment for net migration and territorial coverage.
2. Grouping of data from the two censuses by cohort.
3. Adjustment for interval that is not an exact number of years.
4. Calculation of cohort survivorship ratios.
5. Fitting of a Coale-Demeny model life table.
6. Completion of the life table.

2.2.2 Smoothed by Use of The Logit System

The steps of the computational procedures are described below.

- 1-4. These steps, by which cohort survivorship ratios analogous to those for a stationary population, are identical to those described in subsection 2.1.1.
5. Smoothing cohort survivorship ratios by use of the logit life-table system.

2.2.3 Estimated by Using Projection and Cumulation

The steps of computational procedures are described below.

- 1-3. These steps, by which two comparable age distributions for time-points separated by an exact number of years are obtained, are identical to those described in subsection 2.1.1.

4. Cumulation of the second age distribution.
5. Projection of initial population with different mortality levels.

2.3 Research Procedures

1. Collect references on the estimated mortality or mortality of adults using census data.
2. To collect data from publications on the official website of the Indonesian Central Bureau of Statistics.
3. Describe data on the number of Indonesian men by age group in 2010 and 2020
4. Data Analysis
The data analysis process includes: adjustment for net migration and territorial coverage, grouping of data from the two censuses by cohort, adjustment for interval that is not an exact number of years, calculation of cohort survivorship ratios, fitting of a Coale-Demeny model life table, and completion of the life table.
5. Compile life table.
6. Comparing the estimated life table results with the life tables produced by the Central Statistics Agency (BPS - Statistics Indonesia)
7. Make conclusions and suggestions.

3 RESULT AND ANALYSIS

Analysis result of this study can be described below.

1. Calculation of the number of people who can be survive to age x , it is done by looking for the value of $l(x)$ that have been formed using the interpolated value from the 18.38 level that has been obtained, multiplied by the radix value, which is the initial number of calculations in the life table which is useful for making calculations easier in the life table, the value is 100.0000. For the value of $x=0$, $l(0)$ it has been set $l(0)=100.000$.

So if $l(0)=100.000$, it means there are 100.000 babies born alive during of the year 2020.

2. Calculation of the number of people who died between ages of 0 to 1 year, is done by finding the value of $d(0)$ described below:

$$\begin{aligned}d_x &= l_x - l_{x+n} \\d_0 &= l_0 - l_{0+1} \\&= l_0 - l_1 \\&= 100.000 - 93.004 \\&= 6.996\end{aligned}$$

So it means that the total of people who died between ages of 0 to 1 years are 6.996 people.

3. Calculation of the probability of a person age 0 year dying before reaching age 1 year is done by finding the value of $q(0)$ described below:

$$\begin{aligned}q(x) &= \frac{d_x}{l_x} = \frac{l_x - l_{x+n}}{l_x} \\q(0) &= \frac{d_0}{l_0} \\&= \frac{6.996}{100.000} \\&= 0,069957\end{aligned}$$

It found that the probability of a person who ages 0 year dying before reaching the age of 1 year is 0,069957. This means that around 6,9957 percent of the number of live births will die before the baby reaches the age of exactly 1 year.

4. Calculation of the number of years of life lived between the age of 0 and 1 year by the population aged 0 is done by finding the value of $L(0)$ described below:

$$L(x) = l_x - \frac{n}{2}d_x = \frac{n}{2}(l_x + l_{x+n})$$

$$\begin{aligned} L(0) &= \frac{1}{2}(l_0 + l_{0+1}) \\ &= \frac{1}{2}(l_0 + l_1) \\ &= \frac{1}{2}(100.000 + 93.004) \\ &= 96.502 \end{aligned}$$

It found that the number of years of life lived between the ages of 0 and 1 year by residents aged 0 is 96,502.

5. Calculation of the total time spent by a population aged 0 years until the end of their life is done by finding the value of $T(0)$ described below:

$$\begin{aligned} T(x) &= \sum_x^{\omega} L_x \\ T(0) &= \sum_0^{75} L_0 \\ &= 96.502 + 367.335 + 451.236 + \dots + 128.664 \\ &= 5.883.507 \end{aligned}$$

It found that the total time spent by a population aged 0 years until the end of their life is 5,883,507.

6. Calculation of the life expectancy at the age of 0 years is carried out by finding the value of $e(0)$ described below:

$$\begin{aligned} e(x) &= \frac{T_x}{l_x} \\ e(0) &= \frac{T_0}{l_0} \\ &= \frac{5.883.507}{100.000} \\ &= 58,84 \end{aligned}$$

It found that the calculation of the life expectancy age of 0 years is 58.84 years, means that from 100.000 babies born will be able to live to the age of 58 or 59 years.

4 CONCLUSION

From the results of the analysis and discussion, it can be seen from the data that life expectancy (AHH) obtained in this study was 58.84 years, means that from 100.000 babies born will be able to live to the age of 58 or 59 years. The pattern of the number of Indonesian male residents who survive by produced using the smoothed method using the Coale-Demeny life table is close to (has similarities) to the pattern of the number of Indonesian male residents who survive that produced by the Central Statistics Agency (BPS-Statistics Indonesia) using the Log-quadratic method with $k = 0$.

REFERENCES

- [1] [BPS] Badan Pusat Statistik dan Kementrian Dalam Negeri. 2021. *Berita Resmi Statistik Hasil Sensus Penduduk 2020*. Jakarta (ID): Badan Pusat Statistik.
- [2] [BPS] Badan Pusat Statistik. 2014. *Kajian Life Table Indonesia Berdasarkan Hasil SP2010*. Jakarta (ID): Badan Pusat Statistik.
- [3] [BPS] Badan Pusat Statistik. 2012. *Penduduk Indonesia Hasil Sensus Penduduk Tahun 2010 (Population of Indonesia Result of the 2010 Population Census)*. Jakarta (ID): Badan Pusat Statistik.
- [4] [BPS] Badan Pusat Statistik. 2013. *Proyeksi Penduduk Indonesia (Indonesia Population Projection) 2010-2035*. Jakarta (ID): Badan Pusat Statistik.
- [5] Berliana, Sarni Maniar. 2011. *Life Table (Tabel Kematian)*. Jakarta (ID): Sekolah Tinggi Ilmu Statistik.
- [6] Chiang, Chin Long dan World Health Organization. 1979. *Life Table and Mortality Analysis*. World Health Organization.
- [7] Kirana, Dinita Adwitiyas. 2015. *Estimasi Angka Harapan Hidup Menurut Provinsi di Indonesia Tahun 2010 dengan Menggunakan Metode Trussell 1 dan Trussell 2*. Bogor: Institut Pertanian Bogor.
- [8] Purwianti, Tri. 2014. *Pendugaan Life Table Penduduk Wanita Indonesia Berdasarkan Data Sensus*. Bogor: Institut Pertanian Bogor.
- [9] Purwianti, Tri. H. Sumarno dan E. H. Nugrahani. 2017. Pendugaan Life Table Penduduk Wanita Indonesia dan Pengembangannya Menjadi Life Table Kontinu. *Journal of Mathematics and Its Applications (JMA)*. Vol. 6, No. 1. Hal: 13-26.
- [10] Rajak, Muhammad Nor Abdul, Yuki Novia Nasution dan Nanda Arista Rizki. 2018. Penentuan Besaran Premi Asuransi Jiwa dengan Model Apportionable Fractional Premiums Berdasarkan Tabel Mortalita dengan Metode Interpolasi Kostaki. *Jurnal Eksponensial*. Vol. 9, No. 1. Hal: 27-34.
- [11] Ramadhan, M. Hasbi. 2018. *Metode Perhitungan Peluang untuk Data Sample Sebagai Dasar Penyusunan Life Table*. Bogor: Institut Pertanian Bogor.
- [12] Ramadhan, Rio Febri. 2019. Konstrual Diri (Self Construal) Remaja yang Mengalami Kematian Orang Tua. *Jurnal Psikologi Islam Al-Qalb*. Vol. 10, No. 1. Hal: 79-90.
- [13] Riyana, M, H. Sumarno dan B. Suharjo. 2018. Penentuan Metode Terbaik untuk Pendugaan Life Table Penduduk Lanjut Usia di Indonesia. *Journal of Mathematics and Its Applications (JMA)*. Vol. 17, No. 1. Hal: 61-74.
- [14] Samosir, Bulan dan Wilson Rajagukguk. 2015. *Buku Demografi Normal Badan Kependudukan dan Keluarga Berencana Nasional*. Jakarta: UKI Press.
- [15] Siyoto, Sandu dan M. Ali Sodik. 2015. *Dasar Metodologi Penelitian*. Yogyakarta: Literasi Media Publishing.
- [16] Sulistyorini, Agus dan Soenarnatalina Melaniani. 2007. Perbandingan Metode Brass dengan Metode Trussell dalam Menghasilkan Angka Harapan Hidup. *The Indonesian Journal of Public Health*. Vol. 4, No. 2. Hal: 52-58.
- [17] Supono, Vani Rialita. 2009. *Perbandingan Metode Interpolasi Abridge Life Table dan Aplikasinya Pada Data Kematian Indonesia*. Bogor: Institut Pertanian Bogor.
- [18] Tua, Nasib. 2016. Teori Stres: Stimulus, Respons, dan Transaksional. *Buletin Psikologi*. Vol. 24, No. 1. Hal: 1-11.

- [19] [UN] United Nations. 1983. *Indirect Techniques for Demographic Estimation*. New York: United Nations Publications.
- [20] Yusuf, Fiki Muhamad. 2018. *Pendugaan Life Table Multiregional untuk Empat Kategori Wilayah di Indonesia Berdasarkan Sensus Penduduk Tahun 2010*. Bogor: Institut Pertanian Bogor.
- [21] Zulkarnaen. 2012. *Modifikasi Metode Interpolasi Kostaki Dalam Menduga Tabel Hayat Lengkap Berdasarkan Tabel Hayat Ringkas*. Bogor: Institut Pertanian Bogor.